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EXPERIMENTS

AND

OBSERVATIONS

Of the late Eminent

Dr. *ROBERT HOOKE*,

S. R. S.

And Geom. Prof. *Gresh.*

AND

Other Eminent VIRTUOSO's in his Time.

With COPPER PLATES.

Publisch'd by W. DERHAM, F. R. S.



L O N D O N :

Printed by W. and J. INNYS, Printers to the
ROYAL SOCIETY, at the West End of *St. Paul's*.

MDCCXXVI.



T O

The Right Honourable

JULIANA,

COUNTESS-DOWAGER

O F

BURLINGTON,

This Collection of P A P E R S,

As well for her Personal Virtues and Merits,
as for her singular Favours to me, are,
with greatest Respect and Gratitude, hum-
bly dedicated by

Her Ladyship's

Most obliged

Humble Servant,

W. DERHAM.

A M E N D M E N T S.

P A G. 153. Inſert in the Margin at l. 14. *V. Poſt Works.* p. 564.
P. 226. l. ult. after *loofe*, add *in the ſame manner*. P. 227. l. 4.
for *Tab. III.* read *I.* Ib. l. 27. read *Weight K K.* Ib. l. 29, 30. r.
Hook E F. G *the Ring to be hung on the Hook F.* P. 228. l. 31. for
believed, r. *received*. P. 230. ult. r. *Height*. P. 231. l. 25, 26.
r. *Height*. P. 233. l. antepen. r. *Tab. I.* P. 234. l. 17. r.
theſe. Ib. l. penult. after *left* add, *and by that Means*. P. 237.
l. 3. after *Stick* add, *ſmaller, and tapering upwards towards great*
D, which is an hollow very light Ball of Wood. Ib. l. 26. read
Tab. II. P. 238. l. penult. r. *Tab. I.* P. 239. l. 12. r. *Tab. I.*
Ib. l. 20. r. *proportion*. P. 240. l. 4. for *ſo*, r. *by*. Ib. l. 18.
after or add *that*. P. 321. l. 28. r. *Condore*. P. 328. l. 16. r.
abiegno. P. 336. l. 17. r. *Lignum-Aloes, Civet, Storax & La-*
danum. P. 245. l. 5. read *mea*.



T O T H E
R E A D E R.



THE principal Author of these Papers being a Person of great Repute, I thought the Publication of them would be very acceptable to the Curious ; and therefore was willing to undertake the Work, although I found it would be very laborious, by reason the Papers were very numerous, and in great Confusion.

After Dr. Hook's Death, both his Papers, and some of his Figures and Modules (but I fear not nearly all) fell into the Hands of my ingenious Friend Richard Waller, Esq; out of which he selected those that he published in 1705 ; and intended others for the Press : But dying before he had accomplished that Design, a Part of the Papers were entrusted

To the READER.

trusted to me, by Mr. Waller's Lady, and Jonathan Blackwell, Esq; In which I expected great Matters from such illustrious Names, as I found among them: But when I came to peruse, and examine them, I found only here and there some, that answered my Expectation; which the Reader hath in the following Collection. In which he may probably expect some of the many Lectures, which the Doctor read in Gresham College, and those of Sir John Cutler's Institution. But the best of these Dr. Hook himself, or Mr. Waller published: So that what I have in my Hands, will be of little Use to the learned World, most of them seem to have been intended by the Doctor, for half an Hour's Amusement to a small Auditory, rather than for the Press.

As for Order, or Method, little could be observed in such a confused Variety of Subjects, as these Papers contain. And therefore the best I could do, was to rank them, as near as I could, according to the Order of the Time in which they were written, or communicated.

And as for other Papers interspersed with Dr. Hook's, they are, for the most part, of such considerable Persons, that the Reader will expect no Excuse for my inserting of them.

But if any remarkable Obscurities or Imperfections should be met with, it is what I could not help, by reason some of the Papers
were

To the READER.

were torn, some obliterated, some written in an Hand scarce legible, &c. and I was not minded to give my own Sense, lest it should be thought that I had imposed my own, instead of the several ingenious Authors Senses.

But after all, many of those Imperfections, and Obscurities, are owing to the Miscarriage of some of the Papers, which either never came to Mr. Waller's Hands; or, if they did, were lost, or mislaid, before they came to mine, the Papers being put into different Hands, after Mr. Waller's Death. And whereas Figures, or Modules, would have explained divers of the Papers, that are published, and have enabled me to have imparted others, altogether as valuable; but finding few, or none, but what are here published, neither among the Papers themselves, nor in the Repository, nor Papers of the Royal Society, I was forced to be content.

For a Conclusion of this Preface, I shall answer two Accusations that have been, or may be charged upon me: One is, That I have long detained these Papers from the Publick: The other, that I have engaged myself in Matters lying out of my Way. To both which, one Answer may serve, namely, That I have made the collecting, and publishing these Papers, my Diversion, at Leisure Hours: By which Means, and by reason the Papers, out of which these
were

TO THE READER.

were selected, were very numerous, and many of them came late to my Hands, their Publication hath been the longer delay'd. And as for the Diversity of this from the Business of my Profession: I confess it is not direct Divinity, but yet I think it, by no Means, unfit for a Clergy-man's Diversion. For as it is necessary for a Clergy-man (as well as others) sometimes to divert, and unbend his Mind, from his more serious Studies, so what Diversion more innocent, or proper, than that which promotes Knowledge, and Experience, and is a Discovery (if never so small) of any of the Works of the infinite Creator? To the promoting which End, the Publication of these Papers was, in some Measure, intended by

W. DERHAM.





CURIOUS
 PHILOSOPHICAL
Observations and Experiments
 OF
 Dr. ROBERT HOOK,
 AND
 Other Eminent VIRTUOSO's in his
 Time.

*Of the Invention of the BAROMETER,
 in the Year 1659.*



N one of Dr. Hook's Papers (not here published, because imperfect) I find this Remark, viz. *The Instrument, for finding the different Pressure of Air upon the Parts of the Earth subjacent, was first observed by the Honourable Mr. Boyle, who, upon the Suggestion of Sir Christopher Wren, erecting a Tube of Glass so filled with Mercury, as is now*

VOL. I. B usually

usually done in the common Barometer, in order to find out, whether the Pressure of the Moon, according to the Cartesian Hypothesis, did affect the Air; instead of finding the Fluctuation which might cause the Phenomena of the Tides, discovered the Variation of its Pressure to proceed from differing Causes, and at different Times, from what that Hypothesis would have predicted. That Propriety of the Air (for ought appears) was never discovered till that Time, which is not yet thirty Years since, &c.

To this I *W. D.* shall add another Remark I find in the Minutes of the Royal Society, February 20. 167⁸, viz. Upon a Discourse of some Experiments to be made with the Barometer on the Monument, it was queried, how this Experiment of the differing Pressure of the Atmosphere came at first to be thought of? And it was related, That it was first propounded by Sir Christopher Wren, in order to examine Monsieur des Cartes's Hypothesis, Whether the passing by of the Body of the Moon did press upon the Air, and consequently also upon the Body of the Water. And that the first Trial thereof was made at Mr. Boyle's Chamber in Oxford.

THE Time, when these Observations were made, was about the Year 1658, or 59; at which Time Mr. Boyle having a Barometer fixed up, for the observing the Moon's Influence upon the Waters, happened to discover the use of it in relation to the Weather, and to assure himself, that it was the Gravitation of the Atmosphere which kept up the Quicksilver to such an Height, as the learned Abroad, particularly Torricelli, had suspected before.

BUT although this Use of the Baroscope is owing to Sir Christopher Wren, and Mr. Boyle, yet, to do every Man Justice, I shall give

give the History of this excellent Instrument, from the Extracts of a very ingenious Friend.

THE first Inventor of it was *Torricelli*, at *Florence*, in 1643. From whence Father *Mersenne* brought it into *France* the Year following, 1644. And Monsieur *Pascal* being informed of it by Monsieur *Petit*, the Engineer, they both tried it in 1646, at *Rouen*, with the same Success as it had been tried in *Italy*. Some Time after which, an Experiment was made with a Tube of forty six Feet, filled with Water, and also with Wine: Which Experiment Monsieur *Pascal* gave an Account of in a Piece printed in 1647; in which Year he was informed of *Torricelli's* Solution of the Phenomenon, by the Weight of the Air; and devised, for the examining it, the famous Experiment with two Tubes, one within the other; which he mentions in a Letter written in *November* 1647. And lastly, in 1648 the same Monsieur *Pascal* made his Experiments on the Tops and Bottoms of Hills, Buildings, &c. which last Experiments Monsieur *Des Cartes* laid Claim to; affirming, that he desired Monsieur *Pascal* to make them two Years before, and predicted their Success, contrary to Monsieur *Pascal's* Sentiments.

Monsieur *Azour* also laid the same Claim, but it is the most probable that Monsieur *Pascal* had the best Title.

THIS Experiment which *Torricelli* made with Quicksilver, *Galileo* had in effect tried with Water in long Tubes by Pumping; with which he found he could never get the Water to ascend above thirty three Feet: But the Cause he could never hit of.

AFTER the *Torricellian* Experiment had been much celebrated in divers Places, at last *Otto de Guericke*, Consul of *Magdeburgh*, was in-

formed of it by Father *Valerian* at *Ratisbon*, who claimed it as his own Invention: But this was not till the Year 1654. After which *Guerich's* Experiment (called the *Magdeburgh Experiment*) was much talked of.

FROM this short History of the Barometer, not only the Inventor and Improvers of it appear, but in some Measure also the excellent Uses of it: Particularly the Gravitation of the incumbent Atmosphere, (one of the noblest philosophical Discoveries) the Changes of the Weather, &c.

W. DERHAM.

*The Lord Kingkardine's Observations of the
Pendulum Clocks at Sea, in 1662.*

THE Lord *Kingkardine* did resolve to make some Trial what might be done, by carrying a *Pendulum* Clock to Sea; for which End, he contrived to make the Watch Part to be moved by a Spring instead of a Weight; and then making the Case of the Clock very heavy with Lead, he suspended it, underneath the Deck of the Ship, by a Ball and Socket of Brass, making the *Pendulum* but short; namely, to vibrate half Seconds, and that he might be the better inabled to judge of the Effect of it, he caused two of the same Kind of *Pendulum* Clocks to be made, and suspended them both pretty near the middle of the Vessel, underneath the Deck; thus done, having first adjusted them to go equal to one another, and pretty near to the true Time; he caused them first to move parallel to one another, that is, in the Plane of the Length of the Ship, and afterwards he turned one to move in a Plane at Right Angles

Angles with the former ; and in both these Cases it was found by Trials made at Sea, at which I (*i.e.* Dr. *Hook*) was present, that they would vary from one another, though not very much, sometimes one gaining and sometimes the other, and both of them from the true Time, but yet not so much but that we judged they might be of very good Use at Sea, if some farther Contrivances about them were thought upon, and put in Practice. This first Trial was made in the Year 1662 ; whereupon, these being found to be able to continue their Motion without stopping, several other Clocks of this Nature were made and sent to Sea, by such as should make farther Experiment of their Use. And we have an Account which was given from Sir *R. Holmes*, who tried them in sailing from *St. Thomas* West-ward about 800 Leagues, and then tacking about steer'd about 300 Leagues N. N. E. towards the Coast of *Africa*, and by observing these Clocks only, he was able to judge much better than the Masters of the other Vessels that were in Company, who differed from his Account, some 80, some 100 Leagues, some more Leagues ; and whereas several of them thought themselves near to *Barbadoes*, he judged by his Clocks that he was not far from *Fuego*, one of the Islands of *Cape Verde*, and the next Day by Noon reached that Island. But yet this was not so exact as was expected ; however, it performed somewhat towards this Effect of finding Longitudes somewhat more than ordinary, and enough at least to give inquisitive Men Occasion to speculate, and make farther Trial. And though there hath been no very considerable Improvement of that Instrument, or Experiment since that Time by any, and tho' I fear it may at best be insufficient to perform what is necessary to this Matter, yet I question not but that there may be some other Way that

may perform it to a much greater Degree of Perfection, as I shall hereafter endeavour to prove.

Dr. HOOK'S Experiment of weighing AIR.
Shewed to the Royal Society, Dec. 3.
 1662.

Two small Glass Balls, blown and sealed with a Lamp, each of them about an Inch and half over, were suspended at the End of a Beam, and counterpoised with a small leaden Weight; and then a Grain being taken away from the Counterpoise, so that the Balls preponderated by a Grain, the Beam was hung into the Globe, and the Mouth of it clos'd, and the Forcer was wrought; whereupon, as the Air was condensed in the Globe, the Balls by Degrees grew lighter and lighter, and the opposite Counterpoise at length did more preponderate the Globes, than they had before the Condensation; but upon the letting out of the imprison'd Air, the Balls again recovered their Prepollency, and remained as they were when first put in.

THE Experiment affords us a manifest Proof of the Weight and Spring of the Air, and after what Manner they work upon the Bodies inclosed in it. 1st. That though the Air be a heavy Body, yet it not only presses downwards, as some have erroneously thought, and so have imagin'd it should break People's Necks, and roul and press down the Grass, and all kinds of weak Plants, as *Deusignius* supposes; or should press a Dish of Butter, or some such soft Body, quite flat, as Mr. *Hobbs* imagines. But 2^{dly}, it presses upwards and sideways, as much as downwards; whence every Body, suspended in it, does suffer, from this ambient Fluid, a greater

Pressure

Pressure against its under Side to thrust it upwards, than against its upper Side, to force it downwards; and does in all Things of Staticks act according to the same Laws, and after the same Manner, that other heavy fluid Bodies work upon the Body they encompass. And this Experiment, in short, is nothing else but a Variation of *Archimedes's* Experiment of examining compounded Metals. For the two Bodies that weigh against each other, being of a very differing Bulk, though pretty near of the same Gravity when in the Air, when they are encompass'd with a more dense and heavy Fluid, that which is more bulky must necessarily lose more of its Weight or Power downwards than the other, since it is a known Law of the Staticks, that a Body, remov'd out of a lighter into a heavier Medium, loses so much of its former Gravitation, as the Weight of a Part of the heavier Fluid, equal in Bulk to the inclosed Body, amounts to.

THE Uses that may be made of this Experiment may, be many, and those, I think, not the least considerable.

First, It may serve as an Instance, to shew by what Means the Vapours and Exhalations are raised up into the higher Parts of the Air; for if by any Means the Vapours, or Waters rarify'd, obtain a greater Rarity, and consequently a lesser Gravitation than the ambient Air; the Pressure of that must necessarily buoy and carry them up so far, till the Abatement of Pressure on the Parts of the ambient Air, by reason of their sublime Stations in the upper Regions, and till the Abatement of Heat, that kept the Vapours rarify'd, has reduc'd both to an *Æquilibrium*, where they are stay'd and suspended; which affords us a second Use, namely, to explain how the Clouds or Exhalations are suspended and carried to and fro directly at such a Height, and no lower nor higher. For since

it is found by Experiments made by *Torricellius*, that several others, whom I now forbear to name, and the Pressure of the Air at the Top of Mountains is differing from what it is in the Valleys, therefore the Rings of Pressure (if I may so call those Parts of the incumbent pressing Atmosphere) seem not at all to be regulated by the Form of the Earth's Surface; that is, are not at all parallel to the Surface of the Earth, but they seem to be regulated rather by the Distance of the Parts of the Air from the Center of the Earth, or rather are parallel to the Surface (if there be any) of the Air, or to the Superficies of the Sea. And, indeed, I have very often observed, not without Wonder, that in cloudy Weather all the under Surfaces of the Clouds have been exactly terminated with a Spherical Concave Surface, no one being raised above or depress'd below such a determinate Surface. And I have after observed the Vapours often rise like Smoak upward, till they come to such a Height, and then to cease ascending, and spread themselves in Breadth almost like Oil upon the Water: The Reason of all which is, probably, nothing else but that at such a Height the Air is reduc'd by the Decrease of Pressure to such a Degree of Rarity, that it is unable to raise the Vapours any higher, and below it is able to raise them. The Reasons how the Vapours come to retain that Degree of Rarity, &c. is an Enquiry more proper for another Place.

Thirdly, THIS may hint us a Solution of a late Observation made by an excellent Person, and a Member of this Society, that in Fogs with an Easterly Wind, the Pressure of the Atmosphere was observed to be very great. The Reason of which Phenomenon might, perhaps, be this, that the Cold and Pressure of the Air being then very great, the Density and Gravity of it might there-
by

by become so considerable, as to raise up many Bodies, even in the Form of Water, and keep them suspended somewhat above the Surface of the Earth, though by reason of the Want of Heat to rarify those small Parts into aerial Vapours, it were not able to carry them to any considerable Height.

A Brief Account of the Experiments tried before the Royal Society, with Glafs Balls, November 19. 1662. 1. Of driving out the Air by bare Heat. 2. Of driving it out by Vapours of Water and Spirit of Wine. 3. Of their breaking of themselves. 4. Of their breaking by a Knock. 5. Of the Quantity of Water they admitted. 6. Of the Weight of Air they admitted. 7. Of the shrinking and stretching of them. 8. Of their breaking outward.

A SMALL Pipe of white Glafs, melted over a Lamp, is blown into a pretty large Bubble, the small Neck or Pipe of which being, whilst the Ball is yet red-hot, suddenly and carefully sealed up, I observed that those Bubbles being left to cool, some of them that were either not very equally or over thin blown, would, in the cooling, break inward, with a very brisk and loud Noise, some sooner whilst yet hot, others later when even quite cold; but this latter yielded the loudest Report. Some, that were strong and even blown, remained intire when quite cold: The Balls of which I observed to endure a much greater and more violent Blow, before they would break,

break, than others much of the same Make, which were left to cool without sealing up. But, when by a pretty brisk Blow they were broken, they yielded, besides the Noise of the broken Pieces, sometimes a smart, sometimes a more faint Noise. Some of these Bubbles whilst thus hermetically seal'd, being pois'd in a pair of exact Scales, and then the little seal'd End nipp'd off, a *Sibilus* or hissing Noise might very sensibly be heard for a small Space of about a Second; after which the same Scales and Counterpoise being left free, the Bubbles were always observed to preponderate, some a $\frac{1}{4}$ of a Grain, others $\frac{1}{2}$, others more. The End of some other of these being broken off under the Water, the Water was observed to ascend with a very great Impetuosity, and to look white, until such Time as it had fill'd the Bubble or Ball, about $\frac{2}{3}$ or $\frac{3}{4}$ of the whole; some more, some less, according as they were more or less hot when seal'd up. Then holding the Bubble over the Flame of a Candle, till the Water was boil'd or exhal'd away, I immediately seal'd up the small End again, and observed some of them to break with a much louder Crack than those that had been sealed up when red-hot. Breaking others under Water, I found a much greater Quantity of Water to enter, insomuch as to fill almost the whole Ball, leaving a very little Bubble of Air at the Top: Others, that I weigh'd, I found to increase somewhat more in Weight, by the Admission of the Air, than they had done before by the other sealing. After this, having emptied out the Water, I put into several of them a small Quantity of indifferently well rectify'd Spirit of Wine, and taking the small Stem in my Hand, I held the Ball over the Flame of the Lamp, till the Spirit with great Impetuosity was evaporated, and driven out through the small Neck, in a Kind of misty Steam;

Steam; which ceasing, I immediately seal'd up the Neck, and letting the Bubbles cool, I found them to be much of the same Kind with those that I had seal'd up with Water, both as to the Noise they yielded when broke, and to the admitting of Water, and for the weighing of Air; only in this these two last Ways differ'd from the first, that whereas the red-hot Glasses when cold were clear, these, though they appeared clear when hot, were, notwithstanding, all tarnished over, with a Kind of Dew in the Insides when cold; which Dew would quickly disappear, if they were again heated pretty hot. There were several other Circumstances, which, because they will be more notable in other Experiments, I here omit.

THE Reasons of which Phenomena I humbly conceive to be these. *First*, That the elastical Power of the exceedingly heated Parts of the Air, that are within the Glafs when red-hot, being very much intended, a very small Parcel is able to press and keep out all the rest of the ambient, contending Atmosphere; and whilst it has that Ability, the Passage being shut, the ambient Air is hinder'd from rushing in that Way, though the Air within growing colder, and so losing its Elater, could not have been able to have hindered it. * Now the Pressure of the included Air against the Sides decreasing with its Elater, and that with the Heat, and the Pressure of the ambient, remaining the same, that curious arched Vault of the Glafs is forcibly press'd and crush'd together, and so the Particles are put into a closer Texture. And that they are so, I found by this Experiment. I fitted a pretty large Bubble with a slender Neck into a Bolt-Head, whose Neck was drawn very

* Query, *Whether the Bubbles shrink?*

small, and left only big enough to contain the Neck of the Bubble, and whose Bottom was cut off, that thereby I might include the Ball. Having so fitted the Ball and Bolt-Head, I shut up the Bottom again with Cement, and filling up the Space left in the Bolt-Head with Water, till it reach'd into the Small of the Neck, I nipp'd off the seal'd Top of the Bubble, whereupon the Water in the small Neck rose about a Barley Corn's Breadth, which could proceed from nothing else than its Return to its former Dimensions, before it was sealed up; which affords us a noble Instance of Compression, where that so hard and well compacted Body of Glafs is compress'd into lesser Room, and that by no greater a Force than that of the Pressure of the Air; whence we may conclude that the Parts of that Body are not so close joined together, but that there may be Pores or Recesses left between them, into which they may be protruded, and so be made to lie closer to each other, which whether Water and other fluid Bodies may not do the like, Trial will inform.

THE Experiments suggest these Queries.

WHAT may be the Cause of Noise or Sound?

BY what Means Heat rarifies and expands Bodies, and Cold condenses?

WHETHER the Causes of the almost similar Phenomena of the Glafs Drops, may not be deduced from these Principles: Or what may be their Causes?

THE Strength of a Knock, or what may be the Force of falling Bodies?

WHAT is the true Weight of Air in Winter?

WHETHER Bodies, that will not melt, may be expanded by Heat?

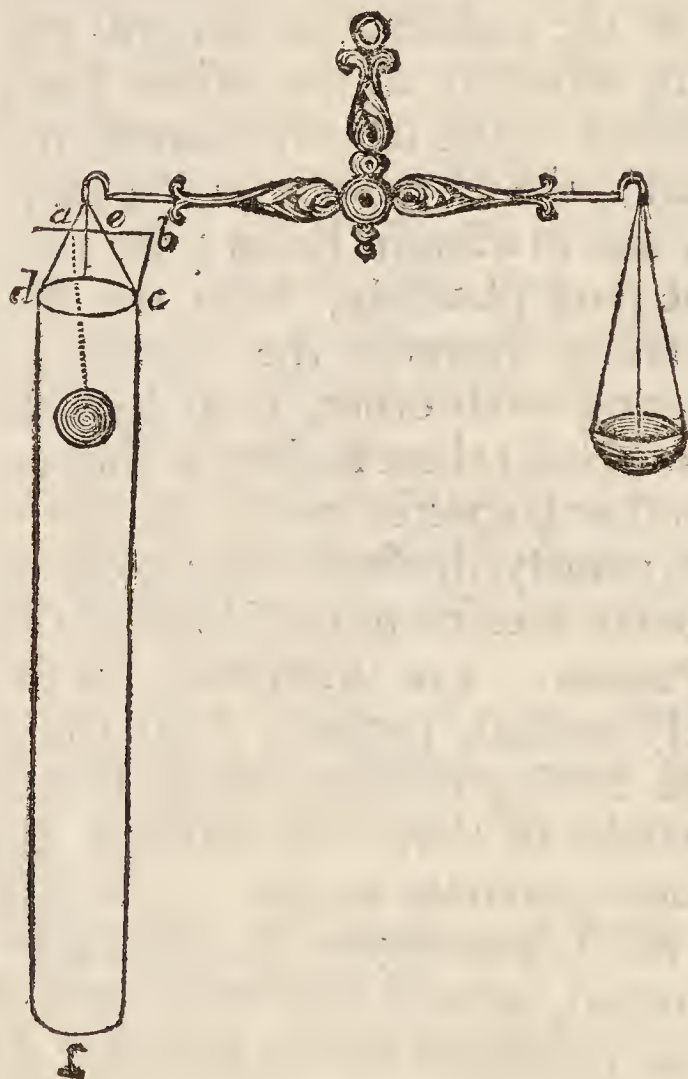
THE Difference of the external and internal Pressure increasing by the Decrease of the included Air's Elater, if some Parts of this Arch (if I may

fo call it) be weaker or irregular, the ambient Pressure breaks it in: Even as in Architecture the fame would happen in thofe larger Arches, if in either of thefe Particulars they deviated from the Rules of that Art. But if fufficiently ftrong and equal, the ambient Pressure makes the chryftalline Vault the firmer, as in Arches of Stone is commonly obferved. The Cause of the Noife I dare not yet determine, but I think it worth a further Enquiry, whether it proceed not from the *Impetus* wherewith the broken Pieces of Glafs are dafhed againft one another, though the Noife feem of another Kind; or from the fudden rufhing of all the Parts of the ambient Air towards the Middle of the Ball, whereby all the other Parts of the circumambient being likewise moved towards the fame Middle, the Drum of the Ear may likewise be moved, and fo a Sound heard: Or 3^{dly}, Which I think the moft plaufible, from the fudden and violent rufhing towards the Center, and (by there meeting each other, or at leaft the broken Particles of Glafs) there finding as fudden and violent a Recoil or Repulfe, one of which two laft (if not a third, namely, the fudden flying out of the Air) feems to be the Reason of the Noife of a difcharged Shot of Powder. The Alteration, as to Weight, does clearly enough proceed from the Admission (which the Hiffing plainly enough fpeaks) of the heavy Particles of Air. A manifef Experiment that Air does gravitate in Air. The violent rufhing in of the Water argues the forceable Pressure of the external, as the Multitude of Bubbles do the languid Refiftance of the included Air.



An Account of some Trials for the finding how much, ascending and descending Bodies press upon the Medium through which they pass : Made before the Royal Society, Dec. 24. and Dec. 31. 1662.

A Glas Tube about fourteen Inches long, and an Inch and half over, being open above, but shut beneath, was hung by a Piece of Tape fastened about the End of it, to the End of a Beam ; then being fill'd with Water, and a



round Glas Ball somewhat more than an Inch in Diameter (which was made heavier than Water, by Quicksilver included in it) being hung by a String

String of Silk so far within the Tube, that it was quite covered with Water. The other End of this String was tied to a Wire, that was fastened to the End of the Tube. This Tube, I say, thus accoutred, being hung at the End of an exact Beam, was counterpois'd with somewhat more than 36 Ounces Troy. Then the Scales being in a very exact Equilibrium, the Silk String, by which the Ball hung, was suddenly cut afunder with a sharp Pair of Scissors. And the Beam, all the while the Ball was descending through the Water, and after it came to the Bottom, kept its former horizontal Parallelism. This was repeated a second Time with the like Success.

At the same Time in the same Tube, as it hung in this Posture, there was let down to the Bottom of it a small Piece of Lead, which had a small Loop of Wire, through which a Silk String being put, a round Glass Ball much lighter than Water, and about the former's Bigness, was, by that String, drawn down, and kept at the Bottom of the Water, and the other End of the String was fastened about the former Wire. This done, the Scales were brought to an Equilibrium, and then, as before, the Thread was cut, and the Ball quickly ascended to the Top; in which Time the Beam was observ'd to be very much turned from its Equilibrium, and upon Trial six Grains, deducted from the Counterpoise, was requisite to bring them to an Equilibrium. This last Experiment was twice repeated, but in the latter Trial the Parallelism of the Scales was not at all disturb'd, as in the former Experiment; which gave Occasion for a Conjecture, that the former odd Phenomenon was caused by some extraordinary Accident.

IN Prosecution of this Enquiry, Dec. 31. Trial was made by a Variation of the former Experiment;

riment; for the Thread of Silk that the Ball hung by, was not tied to the former Wire, but to a *Sustentaculum* above the Beam; then the Scales being brought to an Equilibrium, and the String cut as before, the descending Ball made that End of the Beam, to which the Tube hung, to be exceedingly deprefs'd, and being come to the Bottom it kept the Beam in that Posture.

FURTHER, that it might be known how much heavier that End was than the other, whilst the Ball lay at the Bottom, the Beam was brought to an Equilibrium; after which, six Grains were taken from the Counterpoise of Weights. Then the Ball being tied by a String as before, and the Scale wherein the Weights hung being kept up to a convenient Height, that the Beam might hang parallel to the Horizon, and the String cut as before, the descending Ball was observed manifestly to deprefs the Tube End. Trial was made a third Time by counterpoising and ordering all Things, as in this second Trial, and detracting only three Grains, notwithstanding which, the descending Ball manifestly deprefs'd the Tube End; which last Trials were a Confirmation of the first Experiment, when the Ball was hung to the Wire.

THESE Experiments seem to hint this Axiom, That every Body, whether ascending or descending in a fluid Body, does add so much Weight or Pressure to that fluid Body, as its own Weight amounts to, and not as much as the Weight of so much of the Fluid as is equal in Bulk to what the moved Bodies amounts to.

THIS I should have put as an Axiom, did not some Difficulties suspend my Assent.

First, SINCE the swifter a Body is moved, the greater Resistance it finds from the Medium through which it passes, and consequently the stronger is its Pressure against that Fluid; and since descend-

descending Bodies grow swifter in their Motion, the lower they descend, it seems rational to judge, that the descending Ball's Pressure, on the Water, should be increased with its Swiftnefs.

NEXT, since the Body that hinders its Motion is a Fluid, it seems somewhat difficult to conceive, how the Pressure of a descending Body can be communicated to the Bottom, since the Parts of the Fluid are circulated. And no less difficult is it to say, on what Part of the Bottom the Pressure rests ; whether on the whole, or only that Part immediately subjacent to the falling Ball ; for which Way soever is taken, there are several Difficulties somewhat hard to be explicated.

Thirdly, IF the Weight of the descending Body be all the while sustained by the Fluid, and consequently by the Bottom, how comes the Body, when it touches the Bottom, to press with more Force than its own Weight ; as is evident, in Bodies descending through the Air.

Fourthly, SINCE the Pressure of a fluid Body, against the Bottom, is greater, or less, according to the Height of the Surface of the Fluid above it : It seems that an ascending Body, in Water, does manifestly contradict this Axiom.

COROLLARIES, deducible from these Experiments, certainly made, may be such as these :

First, THAT Exhalations and Vapours press not less upon the Surface of the Terraqueous Globe, when they ascend, than when they are falling ; nay, than when they are fallen : The Certainty of which, I think, were worth examining.

NEXT, That the Pressure of any contained fluid Body, against the Sides of the Vessel, will be abated by opening an Hole at the Bottom ; though the Height of the Water be continued the same. That is, that the Pressure of a Perpendicular

18 *Dr. HOOK'S Enquiries for Greenland.*

Height of running Water, is not the same with that of standing Water.

Thirdly, It should seem, that the Pressure of a River, against the Pillars of a Bridge, is less whilst the Water is running between them, than when that Passage is stopp'd, though the Height in both remaineth the same.

Dr. HOOK'S Enquiries for Greenland.

Jan. 14. 166 $\frac{2}{3}$.

WHAT, and how much, was the Heat of the Sun in the midst of Summer, compared with the Heat of it in *England*?

WHAT is the most constant Weather there, whether clear, cloudy, rainy, misty, foggy, &c? Or what most usual at such and such Times of the Year? Next, what Constancy or Unconstancy there is of the Winds to this or that Quarter of the Horizon, or this or that Part of the Year? What the Temperature of each particular Wind is observed to be; and particularly, whether the North be the coldest, if not, what Wind is? What Wind is observed to bring most Ice, and what to make a clear Water at Sea? What Currents there are, how fast, and which Way they set? Whether those Currents are not stronger at one Time of the Moon than another, whether always running one Way? What is observable about the Tides, Spring or Neap? Whether the Sea Ice be salt or fresh? What Rivers there are in the Summer? What Fowl are found to live there, and what Beasts; how they are imagined to subsist in the Winter; how they breed and feed their young? What Vegetables grow there, and whether they yield any Fruits? How deep the Cold penetrates into the Earth? Whether there be any Wells, or deep Pits, or Mines, wherein the Water will remain unfrozen

unfrozen at the Bottom? How the Land trends? And whether the Parts, under or near the Pole, be there thought to be Sea or Land? Whether the Person made any Experiment, about the Loadstone or magnetical Needle, or any mathematical Observations, about the Height of the Sun and Luminaries, or their apparent Diameters, or Refraction, or the like?

W H A T Fish most frequent those Seas, and any thing about their fishing, with the usual Bigness of Whales, &c. their Strength, the Anatomy of their Entrails? Whether any People do or have been known to stay there all the Winter, and how they do or have shifted? How near any has been known to approach the Pole? What Notice he has taken of the Moon, &c.

Dr. H O O K's Enquiries for Iceland.

Jan. 21. 166²₃.

How deep the Ground is frozen?

W H A T Wind is coldest?

W H A T Rivers and Springs they have?

T H E Anatomy of Whales, or other very large Fishes.

A B O U T the Lungs of Whales and Contrivance of Respiration in other Fishes and Morfes?

C O N C E R N I N G the Fountain that is hot enough to scald a Fowl.

W H E T H E R the burning extraordinarily of *Hecla* portend foul Weather?

R E F R A C T I O N, whether the seven Stars are seen in the *Pleiades*? Whether *Mercury* can be oftener seen than in *England*? The differing Heat of Summer and Winter: How near the Moon may be seen to the Sun?

A N exact Observation of the Eclipses that happen.

20 *Dr. HOOK'S Enquiries for Iceland.*

THE Saltnefs of the Sea-water, by boiling, how much Salt it yields?

THE Height of the Quickfilver in the Torricel Experiment.

WHAT Wind blows most and oftenest?

THE usual Temperature of the several Winds there.

ABOUT Corruption and Preservation of Bodies.

WHAT Bodies will keep in the Snow, what not?

THE burning of the Mountain, other Observations with the Needle in several Places about *Hecla*, or the other fiery Mountains, and in other Places of that Isle.

THE Figure of Snow, whether Hexangular, whether always larger than in these Parts?

THE usual Bigness of Hail-Stones and Figure.

WHAT is observable about Meteors, as *Ignis Fatuus*, Star-shooting, Thunder, and Lightning.

WHAT Kind of Substances are cast out of the burning Mountain.

ABOUT Haloes and Rainbows, any thing extraordinary.

WHAT kind of Ores, Stones, Clays, Minerals, &c. it yields.

WHETHER there be any of the *Selenitis*, or *Muscovy* Glafs to be found there.

THE Declination, Inclination, and Variation of the Magnet in several Parts of the Isle, with the Distances and Latitudes of those Places, as near as may be.

WHETHER the same Point of a Magnet, that is a Pole of that Stone here in *England*, will be so there.

WHETHER the same Part of a *Terrella*, that put upon Quicksilver, will lie toward the Earth here in *England*, will do so there likewise.

W H E T H E R the attractive Virtue of the Magnet increase or diminish there, in respect of what it is found here.

W H I C H Pole is there strongest.

W H E T H E R Iron be more or less apt to rust there than here.

W H A T living Creatures, tame and wild, live and thrive there.

A N Y thing of that Kind strange or remarkable among the Beasts, Birds, Insects, or Fishes ; as about their Generation, living in the Winter ; for what they are or may be made serviceable ; either for Burthen, Swiftnes, Fúrres, Feathers, Meat, &c.

W H A T Kind of Vegetables thrive best in that Island, as Trees, Shrubs, or Plants, and what Kind of Grounds they thrive best in ; what Kinds of Vegetables the Sea yields, differing from our *English*. In what their Husbandry differs from ours, and whatsoever of that Kind is remarkable.

W H A T Woods it yields good for Building, Shipping, or other necessary Uses.

W H A T notable Virtues are attributed to this or t'other Plant ; whether for Divination, Physick, Dying, Smell or Taste, &c.

T H E Seeds of as many as may be gotten together, with their Names.

H O W several Creatures subsist in the Winter.

W H A T are the predominant Colours of Animals.

W H A T general Change is made on the Shipmen, that does not seem immediately to proceed from Cold, as what Diseases they are most subject to.

T H E Nature, Disposition, Manners, and Customs of the Natives.

T H E I R Apparel for Warmth, Houfing, Vi-
ctuals, Firing, Bedding, Cookery, and other Ob-
fervables, either Actions or Utenfils, &c.

A N Y notable Effects produced by Cold, &c.

T H E Height of the Iflands of Ice, their Depth ;
whether it be fresh Water ; whether it feem to be
made up of Snow, and feem to lie in Plates one
above another.

W H E T H E R Spirits appear ; in what Shapes ;
what they fay or do ; any thing of that Kind ve-
ry remarkable and of good Credit.

H O W much the Celestial Bodies are elevated
by Refraction above their true Place.

W H A T Currents there are, the Time of the
Tides in feveral Ports ; their great rifing and fall-
ing in feveral Places ; any thing notable concern-
ing them.

W H A T Condition the Body is in that is pre-
ferved by Snow, whether shrunk or fwell'd, or
chang'd in Colour or Taffe, &c.

W H E T H E R Quickfilver will congeal.

A B L A D D E R full of *Englifh* Air carried thi-
ther, and one of that Ifland Air brought back.



*Dr. HOOK's Proposals, for finding out the
Resistance of the Air, to Bodies mov'd
through it.*

TR Y A L should be made with Pendulums of all Sorts, whose Weights should be made of several Sorts of Materials ; as of Metal, Stone, Wood, Feathers, Wool, &c. and those fashioned into several Shapes, as round, elliptical, square, oblong, flat, to move flat-ways and edge-ways, and the like ; then to have one common Standard, or Pendulum, by which the Celerity and Duration of all the other are to be measured.

T R Y A L S should be made with several of these Pendulums, in the exhausted Receiver, where there is a much less Quantity of Air ; and likewise in the Receiver, where the Air is very much condensed ; and the Differences measured, as before, and recorded, then compar'd with one another, and then with those in the free Air.

T R Y A L S should be made with Bodies of several Substances, and each of those of several Shapes, which should be let fall from several Heights ; and the Times of each of their Descents to be exactly measured by a Pendulum, and recorded.

T R Y A L likewise should be made by shooting, Horizontally, several Kinds of Bodies, with a Cross-Bow, or the like, from the Top of some high Place, and so observing the Time before they touch the Ground. And the

T R Y A L S should be made by shooting Bodies perpendicularly upwards, and so observing both the Time of their Ascent and Descent.

T R Y A L S likewise should be made by shooting Bullets, or other Bodies, Horizontally ; and so to observe with what Force they hit a Body, according as the Body is nearer, or further, from

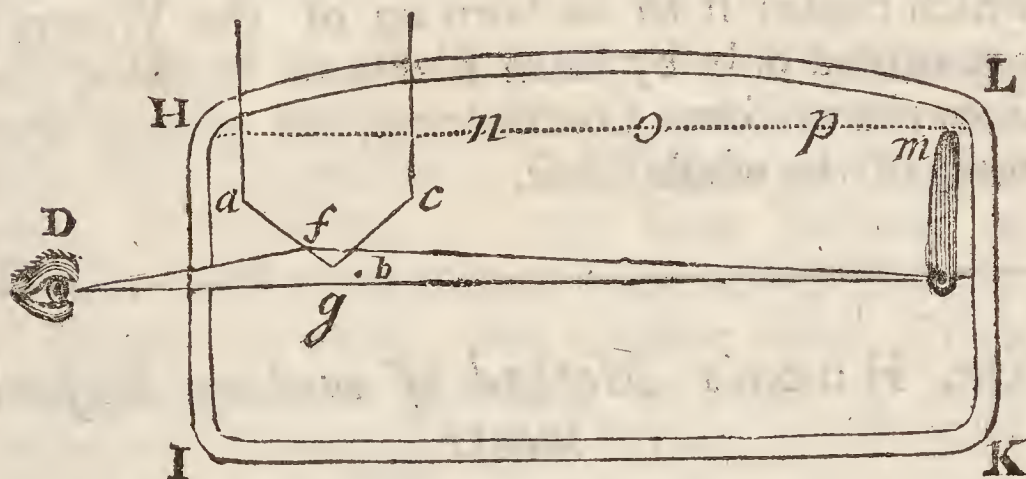
the Instrument that shoots. And these Tryals to be made with Instruments of several Strengths.

Dr. H o o k's Experiment before the Royal Society, February 11. 166 $\frac{2}{3}$. about the Refraction of Ice and Cryſtal.

HAVING observed it to be almost a general Rule in Nature, that of pellucid Bodies, those are found to have greatest Refraction towards the Perpendicular, which are most massy and heavy in Bulk, I chose a very pure and pellucid Fragment of Ice, about an Inch thick, which had very few, if any, perceptible Blebbs or Bubbles in it. Then I took a large cylindrical Cryſtal-Glaſs, about fix Inches over; and filling it with very fair Water, I put into it this clear Piece of Ice, which did manifestly swim, with several of its Parts, above the Water; and though I several Times depress'd it with my Finger, yet would it incontinently rise, as soon as I had remov'd my Finger. Then I took it out, and with a very sharp edg'd Knife, I shaved one End of it, (which is very easy to do) into the Form of a very blunt Wedge, so that the two Sides of the Edge compos'd an Angle of about ninety Degrees; then smoothing those shaved Sides, by rubbing them a little with the Palm of my Hand, I put it into the Water with the Edge downwards, and holding it pretty near that Side of the Glaſs, which was next my Eye, I cou'd plainly perceive, by looking through that Edge, that an Object, placed against the opposite Side, was manifestly refracted. For fastening a small Piece of Lead, so that the lower End of it reach'd about an Inch under Water, I could very plainly see that lower End, a little be-

low

low the Bottom, when, looking through the Ice, the Bottom of it appear'd above the Edge of the Ice; that is, I ſaw the ſame Object in two Places. Now becauſe the Refraction of the Ice made it appear higher than really it was, it ſhews that the Refraction in the Ice was leſs than Water; which will more plainly appear by the Figure: Where H I K L represents the cylindrical Glaſs, that



held the Water; *m e*, a Piece of Lead hung againſt the Side of the Glaſs; *a b c*, the blunt Edge of the Piece of Ice; *D*, the Eye; *n o p*, the Surface of the Water; *f e*, the refracted Line, in which the Point *e* appeared to the Eye; *g e*, the unrefracted. This I ſeveral Times have repeated, and always found the ſame.

THE Uſe of this Experiment may be, 1^{ſt}, For to make an Exception from that general Rule of *M. Des Cartes*, in the ninth Section of the ſecond Chapter of his *Dioptricks*; where he ſays, *Quanto firmiores & ſolidiores exiguæ partes corporis alicujus pellucidi ſunt, tanto facilius lumini tranſitum permittunt*. For, it ſeems, by this Experiment, not to be the greater or leſs Fluidity, or Firmneſs of Body, that cauſes a Difference in Refraction, but a more rarify'd or condens'd Texture.

Next,

Next, IT affords us two Arguments against their Opinion, who affirm Cryſtal to be generated of Ice. For, *First*, As to its Weight, this is found to ſwim upon Water; whereas the other ſinks. *Next*, The Refraction of Cryſtal is obſerv'd to be greater than that of Glaſs; whereas this of Ice I find to be leſs than Water.

Thirdly, THIS leſs Refraction of Ice, I take to be a good Argument, that the Lightneſs of Ice, which cauſes it to be born up of the Water, is not cauſed only by ſmall Blebbs or Bubbles, but from the uniform Conſtitution, or general Texture, of the whole Maſs.

Dr. HOOK's Method of making Experiments.

THE Reason of making Experiments is, for the Diſcovery of the Method of Nature, in its Progreſs and Operations.

WHOEVER therefore doth rightly make Experiments, doth deſign to enquire into ſome of theſe Operations; and, in order thereunto, doth conſider what Circumſtances and Effects, in that Experiment, will be material and inſtructive in that Enquiry, whether for the confirming or deſtroying of any preconceived Notion, or for the Limitation and Bounding thereof, either to this or that Part of the Hypotheſis, by allowing a greater Latitude and Extent to one Part, and by diminiſhing or reſtraining another Part within narrower Bounds than were at firſt imagin'd, or hypothetically ſuppoſed.

THE Method therefore of making Experiments by the *Royal Society*, I conceive, ſhould be this.

First,

First, To propound the Design and Aim of the Curator in his present Enquiry.

Secondly, To make the Experiment, or Experiments, leisurely, and with Care and Exactness.

Thirdly, To be diligent, accurate, and curious, in taking Notice of, and shewing to the Assembly of Spectators, such Circumstances and Effects therein occurring, as are material, or at least, as he conceives such, in order to his Theory.

Fourthly, AFTER finishing the Experiment, to discourse, argue, defend, and further explain, such Circumstances and Effects in the preceding Experiments, as may seem dubious or difficult : And to propound what new Difficulties and Queries do occur, that require other Trials and Experiments to be made, in order to their clearing and answering : And farther, to raise such Axioms and Propositions, as are thereby plainly demonstrated and proved.

Fifthly, To register the whole Process of the Proposal, Design, Experiment, Success, or Failure ; the Objections and Objectors, the Explanation and Explainers, the Proposals and Propounders of new and farther Trials ; the Theories and Axioms, and their Authors ; and, in a Word, the History of every Thing and Person, that is material and circumstantial in the whole Entertainment of the said Society ; which shall be prepared and made ready, fairly written in a bound Book, to be read at the Beginning of the Sitting of the said Society : The next Day of their Meeting, then to be read over, and further discoursed, augmented or diminished, as the Matter shall require, and then to be sign'd by a certain Number of the Persons present, who have been present, and Witnesses of all the said Proceedings, who, by Subscribing

scribing their Names, will prove undoubted Testimony to Posterity of the whole History.

Mr. OLDENBURGH's Letter to Dr. HOOK, Aug. 23. 1665. Concerning the Plague then, and Grass in Sheep's and Oxen's Lungs.

S I R,

I CANNOT but commend you for being so careful of yourself in this dangerous Time, as not to venture to come amongst us, especially when you find yourself any ways out of Temper. The Sickneſs grows ſtill hotter here, though I find by all my own, and other Men's Obſervations, that very few of thoſe Houſes whoſe Inhabitants live orderly and comfortably, and have by Nature healthy Conſtitutions, (you muſt take all theſe together) are infected; and I can ſay, (God be praiſed for it) that as yet not one of my Acquaintance, except an under Poſt-Maſter, who lived cloſely and naſtily, and had all Sorts of People coming to his Houſe with Letters, is dead: So that, generally, they are Bodies corrupted, and Perſons wanting Neceſſaries and comfortable Relief, that ſuffer moſt by this Contagion.

THAT Obſervation, you mention of Mr. Boyle's, is this, that one of thoſe two Phyſicians, Dr. Clerk, and Dr. Lower, had aſſured him, that he had ſeveral Times found, in the Lungs of Sheep, a conſiderable Quantity of Graſs, in the very Branches of the *Aspera Arteria*; and the other had related to him, that a few Weeks ſince, he, and a couple of Phyſicians more, were invited to look upon an Ox, that had, for two or three Days,

almost

almost continually held his Neck straight up, and was dead of a Disease, the Owner could not conjecture at; whereupon the Parts belonging to the Neck and Throat being opened, they found, to their Wonder, the *Aspera Arteria*, in its very Trunk, all stuffed with Grass, as if it had been thrust there by main Force; which gives a just Cause of marvelling and enquiring, both how such a Quantity of Grass should get in there, and how being there, such an Animal could live with it so long.

Extract of a Letter from Ballasore, Jan. 6. 1665. From Mr. Henry Powell, to his Father Mr. William Daniell, upon London-Bridge: Giving an Account of an Earthquake, &c. after the Appearance of the Comet then.

THE same Star appeared in our Horizon, about the same Time 'twas seen with you: The Effects, in Part, have already been here, by unseasonable Weather, great Mortalities amongst the Natives, *English*, and others. We have had several Earthquakes unusual here, which, with hideous Noises, have, in several Places, swallowed up Houses and Towns; but about seven Days Journey from *Ducca*, where were at that Time three or four *Dutch*, they, and the Natives, relate this Story. That in that Place the Earth trembled about 32 Days and Nights, without Intermision; at the latter End, in the Market-Place, the Ground turn'd round as Dust in a Whirl-wind, and so continued several Days and Nights, and swallowed up several Men, who were Spectators, who sunk and turn'd round with the Earth, as in a Quagmire;

Quagmire ; at last the Earth worked up, and cast up a great Fish, bigger than hath been seen in this Country, which the People caught ; but the Conclusion of all was, that the Earth sunk with 300 Houses, and all the Men, where now appears a large Lake, some Fathoms deep : About a Mile from this Town was a great Lake full of Fish, which, in these 32 Days of the Earthquake, cast up all her Fish on dry Land, where might have been gathered many, which had run out of the Water upon dry Land, and there died ; but when the other great Lake appeared, this former dried up, and is now firm Land.

Extract of another Letter from the same Mr. Powell, to the Person abovementioned, from Cassumb, Sept. 27. 1666.

MINE, last Year, advised of the unknown Earthquakes which afflicted most of these Parts, in some to the destroying of whole Towns, viz. June 1st, in Agra, the King's Seat, at three in the Afternoon, such a Darknes possess'd the Country, that none could see his Fellow in the Streets, nor his Hand, though never so near his Eyes, which continued half an Hour, and then dissolved in Rain. It has pleas'd God to send this Year such Rains and Overflowings of the Rivers, that in many Places whole Towns, with Cattle and Men, have been carried away, to the Destruction of many Thousands. About the latter End of August, there was such a Storm about Pattava, that it roll'd, as it were, that great City, their Houses, in Heaps, destroyed many People, and continued three Days and Nights, in which we have lost a Salt-petre Boat of Value, and the

Dutch

Dutch another ; also both ours and the *Dutch* Houses, in all those Parts, are blown down : We expect the same, it being usual with us about the Middle of *October* yearly, but such Inundations and Storms were never before heard of.

An Account of a petrified Bone. An oddly-coated Stone-Bottle : And a double Goose-Egg. Produced before the Society, by Dr. Brown of Norwich, Feb. 27- 1667.

THIS Bone was found last Year, 1666, on the Sea-Shore, not far from *Winterton* in *Norfolk*.

It was found near the Cliff, after two great Floods, some thousand Loads of Earth being broken down by the Rage of the Sea, as it often happeneth upon this Coast, where the Cliffs consist not of Rock, but of Earth.

THAT it came not out of the Sea, may be conjectured, because it was found near the Cliff ; and from the Colour, for, if out of the Sea, it would have been whiter.

UPON the same Coast, but as I take it, nearer *Hasborough*, divers great Bones are said to have been found ; and I have seen a lower Jaw containing Teeth of a prodigious Bigness, and somewhat petrified. All, that are found on this Coast, have been found after the falling of some Cliffs ; where the outward Crust is fallen off, it clearly resembleth the Bones of Whales, and great cetaceous Animals, comparing it with the Skull and Bones of a Whale, which was cast up on the Coast near *Wells*, and which I have by me.

THE Weight thereof is fifty five Pounds.

THIS Bottle was filled with a green *Malaga*, above seven Years ago, and set up in a Nictrio of a Wine-Cellar-Wall in *Norwich*, where it contracted this *Mucor*: It was full at first, and is not yet empty.

A GOOSE-EGG, with another in it, or at least over it; the outward Egg containing nothing but the White. The like I have observed in Hen's and Turkey's Eggs. I would not omit to send it, because though it sometimes happeneth, yet few have the Advantage to see it, especially in a Goose-Egg.

Mr. Charles Towneley's Relation, with Observations of the late Eruption of Water out of Pendle-Hill. Communicated by Richard Towneley, Esq;

AUGUST 18. 1669, betwixt 9 and 10 o' the Clock in the Morning, there issued, out of the North-West Side of *Pendle-Hill*, a great Quantity of Water: The Particulars of which Eruption, as I received them from a Gentleman living hard by, are these. The Water continued running for about two Hours; it came in that Quantity, and so suddenly, that it made a Breast of a Yard high, not unlike (as the Gentleman express'd it) to the *Eager* at *Roan* in *Normandy*, or *Ouse* in *Yorkshire*; it grew unfordable in so short a Space, that two going to Church on Horseback, the one having passed the Place where it took its Course, the other being a little behind, could not pass this sudden Torrent. It endanger'd breaking down of a Mill-Dam, came into several Houses in *Worston*, (a Village at the Foot of the Hill) so that several things swam in them. It issued

out at some five or six several Places, one of which was considerably bigger than the rest, and brought with it nothing else but Stone, Gravel, and Earth. He moreover told, that the greatest of these six Places closed up again, and that the Water was black, like unto that of Moss-Pits; and lastly, that some fifty or sixty Years ago, there happened an Eruption much greater than this, so that it much endamaged the adjacent Country, and made two Cloughs or Dingles, which, to this Day, are called *Oburst* (or, in our *Lancashire* Dialect, *Eraft*) *Cloughs*. Thus far this Gentleman related; what follows take from my self: Going, since this, to see what I could of this Accident, I found nothing that did contradict the abovesaid Relation. What I observed more concerning this and other Eruptions, is, that passing under the North-East End, commonly call'd the *Butt End* of *Pendle*, I saw several Breaches in the Side thereof, at several Distances from the Top; from these, Stones, mix'd with Earth, had been tumbled down, and lay in such a confused Order, as if they had been brought thither by such a like Eruption as this last; and enquiring of a Country Fellow, who was our Guide, he confirmed the Conjecture, and told us, these Breakings out of Water were very frequent, so that he wonder'd we took so much Pains to go and see this late one. I went to look amongst the Rubbish of Stone and Earth, of one of these Breaches, to see if I could find any thing like Ore, but could find nothing. Having pass'd the End of the Hill, and coming to the other Side, we, after a short Time, discovered the mentioned six Breaches, of which two seem'd to be very near the Top of the Hill, and in the same horizontal Line; the others at several Distances from the Top. I went only to the biggest of these Breaches, in which I observed these Particulars:

The Water had taken away the Soil, (which was but about two Foot deep) and bared the Rock, betwixt some twenty and thirty Yards in Breadth, and downwards a considerable deal more: It appeared evidently, that the Water came from betwixt the Swarth and the Rock, for, at the Top of the Breach, we saw several Holes, whereat the Water had issued forth, others were closed up with the Fall of the Earth; wheresoever the Water had taken away some two Foot deep of Earth, the Rock appeared: Amongst the Rubbish I found nothing that could be supposed to come out of the Bowels of the Hill, but only such Stones as might lie loose on the Rock, amongst the Earth that covered it. This is what I observed in the Breach, which, for Bigness, was most remarkable, and presume, I should have found nothing worth Notice in the lesser ones. Though the Noise of this Eruption was so great, that I thought it worth my Pains to enquire further into it; yet, in all these Particulars, I find nothing worthy of Wonder, or what may not be easily accounted for. The Colour of the Water, its coming down to the Place where it breaks forth, between the Rock and Earth, with that other Particular of its bringing nothing along but Stones and Earth, are evident Signs that it hath not its Origin from the very Bowels of the Mountain, but that it is only Rain-Water, coloured first in the Moss-Pits, of which the Top of the Hill (being a great and considerable Plain) is full, shrunk down into some Receptacle fit to contain it, until at last, by its Weight, or some other Cause, it finds a Passage to the Side of the Hill, and then a Way betwixt the Rock and Swarth, until it break the latter, and violently rush out. The great Eruption, mentioned to have happened so many Years ago, perhaps, is that taken Notice of by *Cambden* in his *Brittannia*,

Brittannia, pag. 613. *Verum hic mons damno quod subiecto agro jam pridem intulit maximam aquarum vim eructans, & certissimo pluviae indicio, quoties eius vertex nebulâ vestitur, maximè insignis est.* I know not whether it may not be worth Notice, that going to the Top of the Hill, and observing a considerable Part thereof, especially towards the Skirts, where Turfs had been gotten, I found that the Rock reach'd within a Yard or two of the highest Part; considering this, with what I observed at the mention'd Breach, and several other Places, I think it is very probable, that the whole Mountain, as great as it is, is one continued Rock; and it may be a Question, Whether all other Hills be so or no? But this I leave to further Enquiry.

Extract of a Letter from the President Cornelis Frans, and the Council in Ternata, to the Heer William Maatfuiker, and the Council in Banda, dated the 12th of August, 1673. Concerning Earthquakes there.

WE hereby acquaint you with two Wonders, the like not before heard of. The first, that on the 20th of May, being Saturday Evening, that great and high Hill *Gammaknotra*, about thirteen Miles from hence, is, for the most Part, flown up in the Air, which caused the next Day, being *Whitsunday*, so great a Darkeness, that we could hardly see one another; and this was accompanied with a great Earthquake, and all the Land, both here, at *Manado*, *Cbianco*, *Jasangy*, and *Mindanao*, a hundred Miles from hence, and God knoweth how much further, was covered

36 *Account of Earthquakes at Ternata.*

with Ashes a Foot thick, and so much was fallen in the Sea, that a small fluit Ship, in going and coming from *Manado*, was several Times hinder'd in her sailing, through the great Quantity of Ashes driving, and some Houses and Negeries, at the Foot of the Hill, were quash'd with the Weight of the Ashes fallen on them.

THE second Wonder is, that on the 12th present, in the Night, between 11 and 12 o' the Clock, a sudden Earthquake surprized us, with such terrible Shakings, as possibly the like was never known, which encreased so violently, that the Hill of *Ternata*, on the South Side, was rent from Top to Bottom; the King's *Mandarsabas* Stone-Houses were cast down; Parts of Hills sunk; all the tiled Coverings, with several Walls, cast down; and the Sea was in that Manner disturbed, that the Ships, here in the Road, expected all to have been cast away; and Quantity of Fish was flung on the Shore, with many other strange Passages. And that which is worse, the said Earthquake continueth to this present Time; and here is nothing to be seen but bad Spectacles of Ruin. By a further Letter from the said President of *Ternata*, of the first of *September*, the before-going Relation is confirmed, and that the Earthquake yet continued, so that the Night before, the Houses were thereby terribly shaken; all which is more at large express'd in a Relation printed at *Batavia*.



To whiten Bees-Wax, April 3. 1674.

IN *March* or *April* melt yellow Wax without boiling; then having several Pewter Dishes ready, dip the Outside Bottom of each Dish in fair Water; then dip them into the Wax, and take up a very thin Plate of Wax, the thinner the better: Take them off, and expose them upon the Grass, to the Sun, Air, and Dews, 'till they be milk white, turning them often. Try some of them by sprinkling Water on them with a Cloth. Query, Whether white Lead may not this Way be made with very thin Plates.

Dr. John Carte's Letters to Dr. Grew, of the Belland, caused by the Fumes of Lead, and other curious Observations.

ITHOUGHT it might be worth while to give you a short Account of a Distemper in *Derbyshire*, very common among those, who are employed in the Smelting-Mills, *i. e.* the Houses where they melt the Lead down from the Ore; it is by the Country People called the *Belland*, but for what Reason I cannot learn; it is hard to give a concise Definition of it, because it seldom appears but under the Disguise of another Disease.

THIS *Belland* frequently imitates the *Tormina Ventriscorbutica*, but in a most exquisite Manner, which is usually accompanied with extreme Costiveness, and a continued Suppression of Urine: Sometimes appears like an *Asthma Convulsivum*, sometimes a continued and obstinate *Dyspnœa*, and often seizes the *Genus Nervosum*, either

in a paralytick Resolution of the Parts, or in Spasms.

IT has a different Effect upon Men, according to their Age ; if they come not to the Work of the Mills, till they are full grown, or of a middle Age, they suffer mostly the aforementioned Pains of the Belly, or difficult Breathing. But if taken in while young, and growing, they are subject to the Palsy ; their Limbs (especially their Fingers) being often irrecoverably resolved : Or sometimes have their Fingers so contracted, as to render them (perhaps for ever) incapable of working. Both which I have seen.

I COULD not be informed of any Specificks, they had for this Disease ; but that a Decoction of *Coloquintida*, in Ale, was very common among them. I remember once, an old Man complained to me of the *Belland*, it oppressed him in the Nature of an *Asthma* ; I advised him to sulphurate Medicines, which did relieve him. The Contraction of the Fingers I have known cured, by often putting the Arms into hot Grains after Brewing.

I HAVE not observed, whether any of those, that are paralytick by the *Belland*, die Hectick, as Dr. Pope relates of them, at the *Mercurial* Mines in *Firmly*, but it seems not improbable that they may.

THIS Distemper is not only incident to Men, but other Creatures, as Horses, Cows, Dogs, Cats, Hens, Geese, &c. but, especially, Cats are subject to it : Indeed few Creatures, that are young, will live near these Mills without the *Belland*.

DOGS do in their Fits howl and tumble up and down, foaming like *Epilepticks* ; this the People impute to the Pain of their Bellies.

I KNOW a small Rivulet, on which some of these Mills stand, wherein Trouts have been caught, which have been supposed affected with
het

the *Belland*, by the Irregularity of their Growth, their Heads being great and mishapen, their Backs crooked, their Tails very small, which, I am apt to think, might proceed from their feeding on the *Smitbam* or *Dust* that is washed down at a Flood : For not only the Fumes, but also the Washings of Lead Ore, and the *Waste* (as they call it) *i. e.* the Dust that remains, after the Ore is melted, is very noxious to most Sort of Creatures, and for this Reason, they, that live near the Mills, dare not water their Horses at the River, upon a Flood.

THESE poisonous Fumes are not only hurtful to Animals, but also injurious to Vegetables ; for if the Smoak be driven much upon any one Place, it destroys all the Grass of it.

NOW that the *Belland* in Men, or other Creatures, proceeds mostly from the Smoak, will be easily granted ; but what these Fumes is impregnated with, is the Question : Some fancy them to be Antimonial, but then, methinks, they should have the same Effect with the Flowers of that Mineral, and I never heard that any of them were inclined to Vomit. I am much more apt to think, that the *Mercury* in the Ore is the Cause, both because they, that work in the *Mercurial* Mines, are subject to the like Symptoms, especially the Palsy ; and also I am told, that this *Belland* often begins with a Swelling of the Glands about the Throat, which, perhaps, if not prevented, might terminate in Salivation. But why *Mercury* should operate so variously upon Bodies, differing in Age, is a Question will hardly be solved, till it appear more plainly, whether it be nearer a-kin to Alkalies or Acids : Its Effect is easily foretold in Bodies that abound with Acids, whether Scorbutick or Venereal ; but in younger Persons whose Humours are more insipid, and their Blood freer from both fix'd Salts and Acids, it may, perhaps, fix
D 4 itself

itself upon the Nerves, as the coolest Parts, and impede the Motion of the Spirits ; but I had rather hear others Reasons about the Cause of these Things, than trouble you with my own.

SOME other Things I have been informed of by the Work-men, as that a little Spar mix'd with the Lead Ore, promotes its Fusion, I suppose, as the yellow Marchasite, that's found with Silver, makes that Metal flow the sooner : That if there be any Holly-Wood in the Fire, it hinders the fluxing of the Ore, which is certainly caused by the glutinous Sap of that Wood.

THAT the Smoak is observed to follow the Water very much : I suppose the Coldness of the Water does condense the Fumes, as is seen in reviving *Mercury* from *Cinnabar*. A blue Film is observed on the Surface of those Waters, where the Smoak falls.

THAT a Man may by wetting his Finger in his Mouth, or common Water, draw it through melted Lead or Iron, without any Prejudice.

Sir, THESE Observations will seem barren, yet as good as I could make among these boorish People of the *Peak*, few of which can give a rational Account of either what they do, or suffer, in such Matters.

I am,

Manchester,
Octob. 27.
1678.

Sir,

Yours, &c.



*Part of a Second Letter to Dr. Grew,
Dec. 6. 1678.*

S I R,

SINCE I writ to you about the *Belland*, I have been in *Derbyshire*; all, that I could learn farther of it, was, that they are less subject to that Distemper in those Smelting-Mills, that stand in an open and moveable Air, or that have large Chimnies, and are not built close: I met with a Gentleman who told me, a Servant or two, of his had it very severely in their Bellies, and were cured by taking the Salt that comes from the Sulphur-Well at *Knaresborough*; this Remedy is, I think, one of the likeliest I have heard of.

Dr. HOOK's Description of his Weather-Wiser; about Dec. 5. 1678.

THE Weather-Clock consists of two Parts; *First*, that which measures the Time, which is a strong and large Pendulum-Clock, which moves a Week, with once winding up, and is sufficient to turn a Cylinder (upon which the Paper is rolled) twice round in a Day, and also to lift a Hammer for striking the Punches, once every Quarter of an Hour.

Secondly, OF several Instruments for measuring the Degrees of Alteration, in the several Things, to be observed. The first is, the Barometer, which moves the first Punch, an Inch and Half, serving to shew the Difference between the greatest and least Pressure of the Air. The second is, the Thermometer, which moves the Punch that shews

the Differences between the greatest Heat in Summer, and the least in Winter. The third is, the Hygroscope, moving the Punch, which shews the Differences between the moistest and driest Airs. The fourth is, the Rain-Bucket, serving to shew the Quantity of Rain that falls; this hath two Parts or Punches; the first, to shew what Part of the Bucket is fill'd, when there falls not enough to make it empty itself; the second, to shew how many full Buckets have been emptied. The fifth is, the Wind Vane; this hath also two Parts; the first to shew the Strength of the Wind, which is observed by the Number of Revolutions in the Vane-Mill, and marked by three Punches; the first marks every 10000 Revolutions, the second every 1000, and the third every 100: The second, to shew the Quarters of the Wind, this hath four Punches; the first with one Point, marking the North Quarters, *viz.* N: N. by E: N. by W: N. N. E: N N W. N E by N. and N W by N. N E. and N W. The second hath two Points, marking the East and its Quarters. The third hath three Points, marking the South and its Quarters. The fourth hath four Points, marking the West and its Quarters. Some of these Punches give one Mark, every 100 Revolutions of the Vane-Mill.

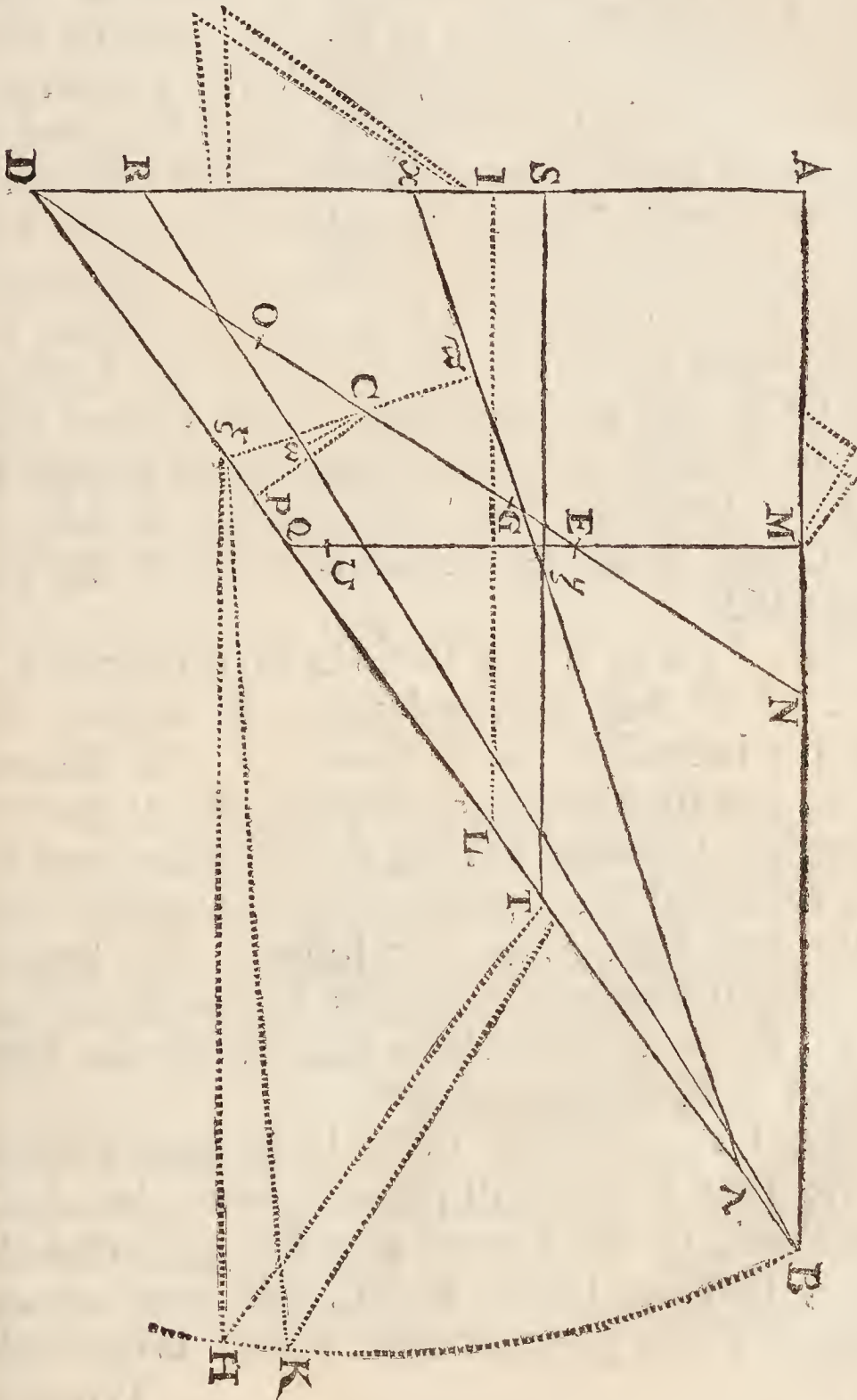
THE Stations or Places of the first four Punches are marked on a Scrawl of Paper, by the Clock-Hammer, falling every Quarter of an Hour. The Punches, belonging to the fifth, are marked on the said Scrawl, by the Revolutions of the Vane, which are accounted by a small Numerator, standing at the Top of the Clock-Case, which is moved by the Vane-Mill.



Dr. HOOK'S Contrivance of a Vessel, to
measure the Quantities of Rain falling :
Being a Part of his Weather-Wiser in the
preceding Paper.

PROBLEM.

To make a Vessel, which, when it hath re-
ceived a certain Quantity of Water, shall
empty itself.



L E T the Vessel be a Triangular Prism, as α poiz'd like a Balance upon a Foot, so that the lesser End may only descend, and not the greater, by means of the Stop D. And let one of the Sides be ABD. From N, the Half of AB, draw the Line DN; and from $M\frac{1}{3}$ of AB, draw MQ parallel to AB; therefore E shall be the Center of Gravity of the Triangle ABD. And because AB is an open Side of the Vessel, some Point between E and D, as G, shall be the Center of Gravity of the whole Vessel; taking a Point at P near Q, towards D, erect PC, and let C be one of the Centers of Motion, upon which, and the like opposite Point in the other Side of the Vessel, it shall turn as a Balance. *Secondly*, By adding Weight in O opposite to G, equiponderate the whole Vessel upon the Center of Motion C; therefore DCN will be a Balance, whose Center is C, and the Weights of equal Moment are G and O. *Thirdly*, Draw the Line ST parallel to AB, so that C may be the Center of Gravity of the Triangle DST.

First, I s A Y, if the Vessel be fill'd short of ST, the Side D shall preponderate; if higher, the Side B; because C is the Center of the Balance DCN, and the Centers of Gravity of all the like Triangles, less then DST (as DIL) are upon the Arm DC, and the Centers of all the greater upon the Arm CN. Hence it follows, that because it is stopp'd from descending at D, the Vessel shall rest till the Water rise above ST, when the Side, towards B, shall preponderate.

2dly, I s A Y, if the Vessel be inclined towards B, the Part B shall still preponderate; let ABD be inclined, (C the Center as before;) so that the Water, that lay before at ST, lies now as $\alpha\zeta\lambda$, and let πC be a perpendicular Line, because the
Triangles

Triangles DST , $D_{\kappa\lambda}$ are equal, but $\zeta_{\kappa}S$, the Triangle nearer the Perpendicular, is taken away, and $\zeta_{\lambda T}$, being farther off, is added on the Side towards B ; therefore that Side preponderates, and the more the lower it descends, because the Center of Gravity, of the Triangle $\zeta_{\lambda T}$, runs farther and farther from the Perpendicular, till it runs over at B .

3dly, I s A y, that when a Part given of the Water is poured out, the Residue still preponderates, while it remains inclin'd. Let the Water be represented by the Triangle DRB in the Motion of pouring out, Part being run over; the Center of Gravity of the Water, is v in the Line MQ : and C^{ω} at right Angles to BR , will be the Perpendicular, as CP will be the Perpendicular when B is descended so low, that DB becomes horizontal, (that is, when all the Water must be poured out) therefore CP is between CO and v , but by Construction the nearest Point of MQ is without CP towards B , therefore v preponderates; therefore the Vessel still inclines, till all be poured out. Therefore that, which was required, is perform'd.

S C H O L I U M.

I F it be requir'd that the Vessel, after it is empty, should return again to its former Position, there must be added to the Point O yet more Weight at K , enough to restore the emptied Vessel, in which Case a Triangle may be drawn as DBR , whose Weight upon its Center v shall equiperponderate to K in O ; it seems therefore, that the Vessel should descend no lower than till BR be horizontal. But because nothing that moves towards an Equilibrium rests there, but is carried further by the impress'd Force which it gains in descending

scending to this Equilibrium, as it appears in all Manner of pendulous Motions. And because K may be less than any Magnitude assigned, therefore, notwithstanding the Counterpoise of K, it will descend so low, as to pour out all ; that is, having gain'd an impress'd Force in its Descent from B to K, there is no Reason but it should continue it beyond the Equilibrium to H and further.

Besides this, I find two other Contrivances of Dr. *Hook's*, among the Minutes of the Royal Society of *April* 1670. for measuring the Rain that falls, in these Words: Mr. *Hook* shew'd an Experiment in Mechanicks, which was a Way how to take notice of all the Rain that falleth, and was designed as a Part of the Weather-Clock. The Contrivance is the suspending the Bucket that was to receive the Quantity of Rain, that fell at any time (whether more or less) so that according to the Quantity therein contain'd, the Place thereof should either be higher or lower, but certainly be determin'd. This was perform'd by a Counterpoise to the said Bucket. The Counterpoise was contriv'd two Ways ; either by a String of leaden Bullets, so order'd, that when the Bucket was quite empty, all the Bullets rested upon a Table ; but when there fell as much Water into the Bucket, as equall'd the Weight of one of the leaden Bullets, then the Bucket descended one Space, and one Bullet was lifted up ; when twice as much, two Bullets ; and when three times as much, three Bullets were lifted up ; and so forward, till all the Bullets were lifted up, and the Bucket had descended to its Place of Emptiness ; whereupon the Chain of Bullets presently descended, and lifted up the Bucket into its empty Place.

But because this Motion proceeded by Jumps, and was not equable, therefore a second Contrivance was also shewn, which was this,

The Counterpoise to the Bucket, when empty, was a Cylinder immersed into Water, *Mercury*, or any other Fluid. Which Cylindrical Counterpoise, according as the Bucket receiv'd more and more Water, was continually lifted higher and higher out of the Water, by Spaces always proportioned to the Quantity of Water that was contained in the Bucket. And when the Bucket was fill'd to its designed Fulness, it immediately emptied itself of the Water, and the Cylinder plung'd itself into the Water, and raised the Bucket to the Place where it was, again to begin its Descent.

This Contrivance, here made use of, was declar'd to be very useful for making a new and useful Beam, for examining the Weight of Bodies, without any Trouble of adjusting, the Rising of the Cylinder immediately shewing the determinate Weight of any Body, put into the Scale, without any farther Trouble.



Mr. TOINARD's Observation of the Difference of Longitude between Paris and Brest, with Observations of Jupiter's Satellite Eclipses, in 1679.

| | H. | ' | " |
|-----------------------|----|----|----|
| 10 Dec. 79. A Paris à | 12 | 50 | 08 |
| A Brest a | 12 | 22 | 37 |

| | | | | |
|--|---|----|----|----|
| Brest selon le grande Carte de France de Samson del' an 1650 est plus occidentale que Paris de degr. | - | 08 | 10 | 00 |
| Qui valent le temps de | - | 00 | 32 | 40 |
| Mais l'observation faite 10 Dec. donne de difference | - | 00 | 27 | 31 |
| Par consequence la Carte qui eloigne Paris de Brest de | - | 00 | 32 | 40 |
| Dont il faut ôter la veritable difference | - | 00 | 27 | 31 |
| Se trompe de | - | 00 | 04 | 22 |
| Qui valent plus d'un degre & un cart. | | | | |

| | | | | |
|---|---|----|----|----|
| 3 Dec. 79. A Paris l'immersion du Grand | | | | |
| 19 Satellite à | - | 10 | 53 | 23 |
| A Paris l'immersion du Premier a | - | 09 | 16 | 03 |

Son gros camarade environ demie heure & demie cast apres.



Monsieur TOINARD's Observations of the Eclipses of Jupiter's first Satellite in 1680.

Satellitæ Jovis primi seu proximi immersiones in umbram Jovis Parisiis, 1680. Stilo novo.

| | D. | H. | M. | | D. | H. | M. |
|--------|----|----|----|--------|----|----|-----------|
| Sept. | 12 | 16 | 20 | Octob. | 16 | 7 | 30 |
| | 14 | 10 | 50 | | 21 | 14 | 55 |
| | 21 | 12 | 45 | | 23 | 9 | 25 |
| | 23 | 7 | 15 | | 28 | 16 | 50 |
| | 28 | 14 | 40 | | 30 | 11 | 20 |
| Octob. | 5 | 16 | 35 | Nov. | 4 | 18 | 45 |
| | 7 | 11 | 5 | | 6 | 13 | 15 |
| | 9 | 5 | 35 | | 8 | 7 | 40 |
| | 12 | 18 | 30 | | 13 | 15 | 10 |
| | 14 | 13 | 0 | | 15 | 9 | 40 vel 35 |

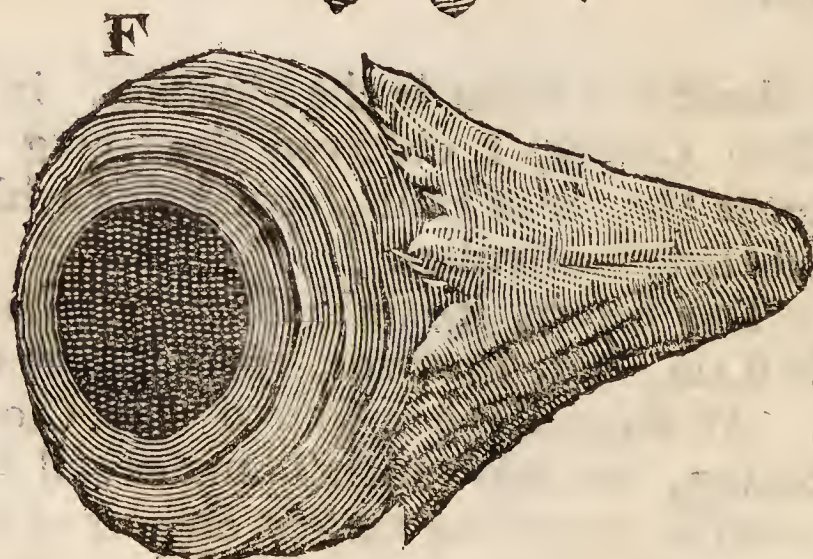
Dr. HOOK's Account of the great Hail-stones that fell in London, on May 18. 1680.

AT about 10 $\frac{3}{4}$ Hour in the Morning, in Gresham College, I observed the falling of a great Shower of Hail; concerning which, I observed these Particulars.

THE Day before, it rain'd almost, all the Day, a gentle Rain, and, by turns, the fore-part of the Night. At about three or four o' the Clock in the Morning, was very much Thunder and Lightning, with an exceeding violent Shower of Rain; whether any Hail then fell, I know not, being in

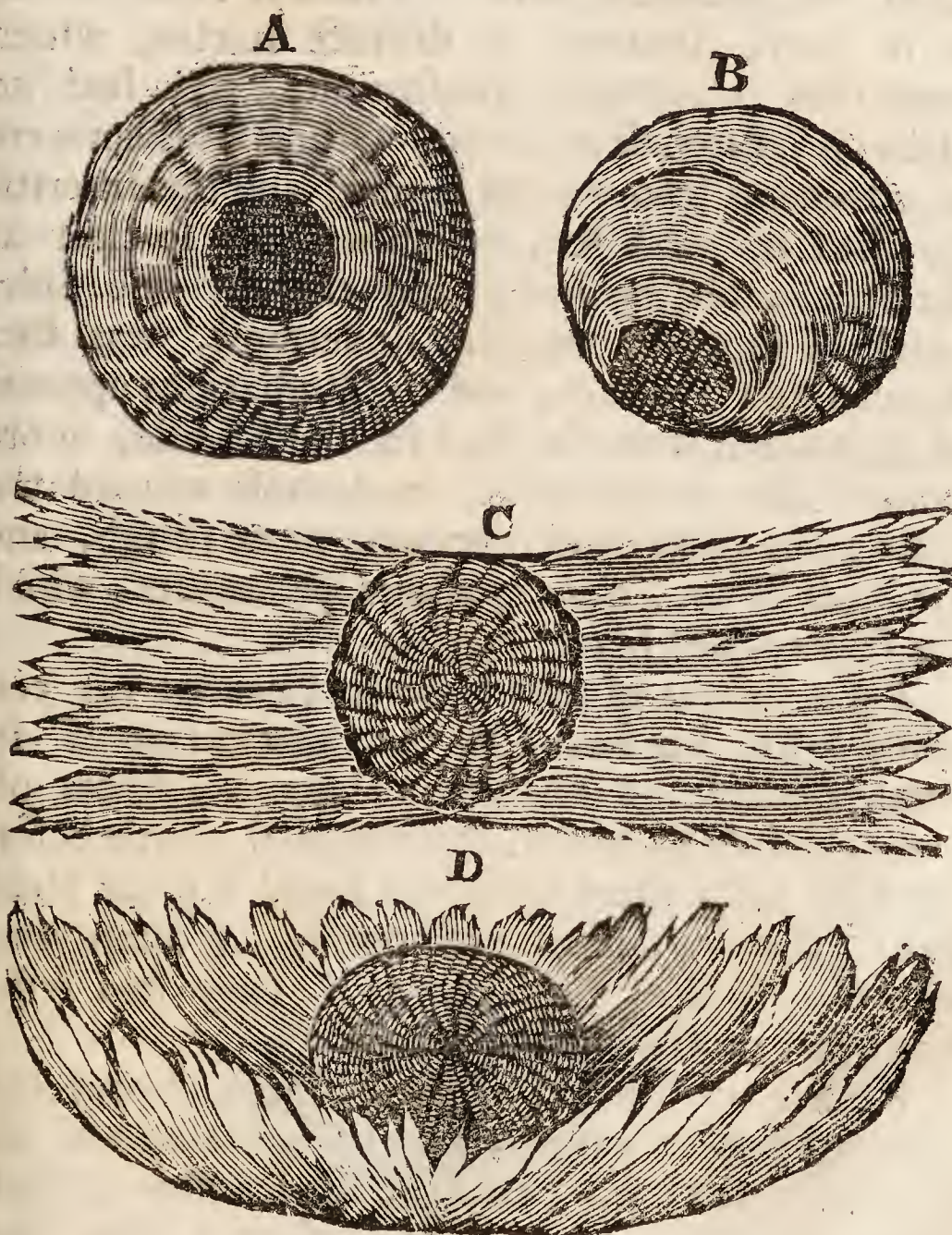
50 *Of Hail-stones that fell in London.*

Bed ; but, by some Circumstances, I believe there did, for there were found, in the Morning, several great Spots of Wet, which, 'tis probable, proceeded from Hail-stones that fell down the Chimney. It continued to rain, and now and then to thunder much, till about Nine ; then it clear'd up, and the Sun shone very clear, and



Of Hail-stones that fell in London. 51

there was scarce a Cloud to be seen ; about ten it began to thicken, and I heard the Thunder to the South East ; at about half an Hour after ten, it grew very dark, and thunder'd very near ; and soon after there began to fall a good Quantity of Hail-stones, some of the Bigness of Pistol Bullets, others as big as Pullets Eggs, and some above $2\frac{1}{2}$ Inches, and near three Inches over the broad Way ; the smaller were pretty round, and white, like Chalk, or Sugar Plums ; the other of other Shapes : Some of the most remarkable were these.



BREAKING many of them, I found them to be made up of Orbs of Ice, one encompassing another; some of them transparent, and some white, and opaque; some of these were to the Bigness of near an Inch in Diameter, and were orbicular every Way. Some of them had the white Spot in the Middle, as A; others towards one Side, as B; and the Variety of white and transparent Spots very differing; those, which exceeded these in Bigness, were made by an additional Accretion of transparent Icicles, radiating every Way from the Surface of the White Ball, like the Shooting of Niter, or toothed Sparre. These in some stood, as it were, separate in distinct Icicles, which were very clear and transparent, and had no Blebs or Whiteness in them. Others of them were all concreted into a solid Lump, and the Interstices filled up with Ice, which was not so clear as the *Stiriæ*, but whiter; and thereby one Side, which, I suppose, was the undermost, was flat, almost like a Turnep; and the Radiations appeared to proceed from the Ball in the Middle, more towards the upper Side, and most toward the Sides; the Edges and Top were more rough, and the Ends of the *Stiriæ* appeared prominent; which the Figures will better express.

THE Extent of this Shower I cannot yet certainly learn, but have, by the Information of several, understood it was seen above ten Miles off. I was also told by several Persons, that, a little before the Hail fell, there were was heard a great Noise out of the Sky, like the Shooting, or Emptying, of a Cart-load of Pebbles, as if they had fallen one upon another in the Air.

FROM the Manner of their Figure, I conceive, their Accretion was made by a Congelation of the Water, as they fell; that the small white Globule in the Middle, about the Bigness of a Pea, was the

the first Drop that concreted into Hail ; this, in falling through the Clouds beneath, congealed the Water thereof into several Coats or Orbs, till some of them came to the Bigness of Pigeons Eggs, some white, some transparent, according to the several Degrees of Coldness it passed through, whilst they congealed ; that the last Accretion was made by a more violent and sudden Cold, in the lower Part of the Cloud, where they passed through almost a continued Body of Water. Other Varieties of their Forms, which were very many, I conceive, must be made by their meeting with one another in their Passage.

NOTWITHSTANDING *Mr. Waller hath published the Substance of this Paper, in Dr. Hook's Life, p. 22. yet the Original may not be unacceptable to the Reader, by reason of the Figures, which the Doctor hath given of those monstrous Hail-stones; which I, my self, saw falling, in great Numbers, in Great Lincoln's-Inn-Fields, and notic'd to have fallen on May 19. 1680. one of which a Servant brought me in his Hand, as large as a Turnep, and of the same Shape, which I instantly measured with a String, and found the Compass of the widest Part to be above thirteen Inches; which, I confess, seems somewhat incredible; but, I think, I did it with great Care, and was not mistaken.*

W. DERHAM.



*The Reverend Mr. PASCHALL's Letter
to Dr. HOOK, of an Earthquake in
Somersetshire, dated Jan. 4. 1680. from
Chedsey in that County.*

Worthy Sir,

YESTERDAY about seven in the Morning, I, being about to rise, took Notice of what seemed a smart Gust of Wind, which was followed with a Jog of our House, and that immediately with a very sensible Shaking of the House, and particularly the Bed in which I lay. I doubted the Fall of some large Piece of Timber, or Stone-Work, and caused the Servants to make diligent Search all about for the Cause of it ; though not without Suspicion that it might be an Earthquake. Before Night I became fully satisfied that it was so, for my Neighbours, many, observed the like in their Houses, though no Hurt was done. This Day, I hear, that it was in other Parishes, one within a Mile of me, lying in the same Level ; another above four Miles from me, lying on the further Side of an Hill, and which is a firm Rock. This Afternoon comes a Letter from an Acquaintance of mine in *Bridgwater*, (two Miles from me, and on the other Side of their navigable River) which says thus, “ I suppose you heard of
“ the Earthquake, which happened with us this
“ Morning about seven a Clock : It shook our
“ strong Stone-House so, that I began to look
“ whether the Walls were scattered or crased, with
“ a Noise, as if some very great Thing had fallen
“ upon the Ground. One or two in *Eastover* (a
“ Part of that Town on our Side of the River)
“ were ready to leap out of Bed upon it, &c.”
The Air was very calm, as being a frosty Morning, upon the Snow lying, which fell the Day

before.

before. It lasted but a very short Time. I do not remember, for these eighteen Years of my Abode here, to have known any such thing ; but I call to mind the Observation of *Acosta*, and others, that they do most commonly happen in Places near the Sea, and such is our Country ; of which I meet many Arguments which persuade, that it was, in these Parts of it, formerly gained from the Sea. If you see my Lord of S—, I presume, it would not be unacceptable to his Lordship, to have an Account hereof, seeing, 'tis likely, it will be a Matter of publick Discourse.

*An Extract of Mr. Leuwenhoek's Letter
from Delf, Jan. 6. 1680. Concerning
the Minuteness of some Animalcules in the
Waters.*

— S I N C E I perceive you are pleased with some of my Speculations, I have, herewithall, transmitted also a Copy of that hasty Calculation, which, at the Desire of the Honorable *Constantine Hygens van Zutichem*, I drew up for him in Writing ; which was this which follows.

S I R,

I HAVE been often considering of the exceeding Smallness of those Vessels, of which the Sinews and Muscles of these small Creatures must be furnished with : That which put me upon this Speculation was, the Query put to me, Whether I could, by my Microscope, discern the Particles of which Water doth consist ? To which I frequently gave this for an Answer, That there are in the Water living Creatures, many Millions of

56 *Smallness of the Particles of Water.*

Times smaller in Bulk than a small visible Sand. Further, That each of these Creatures, though I have not, as yet, been able to discover their Paws, Finns, or the like Instruments, by which they move, must, nevertheless, be furnished with some Kind or other of Organs, fit to produce that Motion. And that these Organs must be made up of Veins, Arteries, or Vessels, to convey Nourishment to them, and in Sinews or Strings, to stir and move by, &c. If so, then by these Vessels the Water must find its Passage, and consequently the Particles of Water must be considerably smaller than these Vessels, otherwise it could not freely pass them; now the whole Animal itself, being but scarcely visible, we must conclude, these their Vessels must be wholly invisible, and how much more invisible must be the Parts of Water that move in them; insomuch that I am very confident, that no Man will ever be able to attain, by the Help of Microscopes, to discover and distinguish the Particles of which Water doth consist.

Now that there are such Creatures, that are so many Times smaller in Bulk, than a small visible Sand, I prove by these following Observations and Calculations. I do generally suppose (because, as far as my Sight was able to help me, in taking the proportionate Bigness, I so judged it) that about 3 or 400 of the smallest of these Creatures, laid one by another in a Line, may make the Length of the Diameter of a middle-siz'd Grain of Sand. I here shall make use only of the lesser Number, *viz.* 300; which multiplying cubically, I find the Product to be 27000000; whence it follows that there will go the Quantity of 27 Millions of these Animals, to make the Bulk of one small Grain, &c. If we then suppose that eighty of these Sands, laid one by another, will make

but

but one Inch in Length, then there will lie in the Space of a Cubical Inch no less than 512000 of these Sands, each of which being supposed to be as big as 27000000 of these Creatures, the Inch Cubical will contain no less than 13824000000000, almost fourteen Millions of Millions.

I HAVE considered also of the small Vessels, that serve to compose the Parts of our Bodies, and conceive them to be Pipes a thousand Times smaller than an Hair of a Man's Head ; and by a Brass-Rule, curiously divided into Inches, and each Inch into thirty Parts, endeavouring to find, how many of these Hairs Breadths would make an Inch, I found that twenty Hairs would lie one by another in the thirtieth Part of an Inch, and therefore 600 in an Inch ; and measuring my Body, I found that one Part, with another, equall'd a Cylinder of eight Inches Diameter ; so that these Proportions consider'd, I find, that one of these Vessels must be 360000000 smaller than a Pipe of an Inch Diameter, and, consequently one Part of the Body being equal to a Cylinder of eight Inches Diameter, which is 64 Times as big as one of an Inch, the Cylinder of the Body is bigger than the Cylinder, of one of these Vessels, no less than 23040000000. Now if the Vessels of the Bodies of these small Creatures, in Pepper Water, should hold the same Proportion to their Bodies, how can we conceive the Parts of the Water should be discovered, that should move in those Vessels.



Reiselius his Letter to Dr. Grew, concerning a Man's periodical Loss of his Speech, from Stutgard, March 6. 1680.

At enim, ne sine symbolo coram altari vestro sanctissimo appaream, appono hic Casum quendam merè naturalem quidem, ut mihi videtur, propter multos similes affectus periodicos Cephaleos pictum, Convulsiones, Colicas, ut de Febribus nihil dicam, sed rarum tamen, ob tam constantem tamq; multis annis durantem periodum, uti observatus fuit a Collega meo examinante in presentia Principis nostri aliorumque magnatum *Novembri* mense præteriti anni. Cujus causam, cum neque mihi neque aliis detur assequi, ab Societatis Regiæ Judicio discere gaudeo & rogare audeo. Quomodo a fermentatione quadam ut in Febribus aliisq; morbis deducenda sit hæc affectio, hæreo. An a cœli meridiano vigore trahendum malum seu bonum, dubito, cum olim aliis horis & inordinate notata sit hæc affectio. Symptomata tamen, quæ quondam antegressa, morbosum quid innuunt. Hic talis est. *Georgius Algaier, Georgii Algaieri* Cauponis *Jesingæ* propè *Kircseium* in Ducatu *Wirtenbergico*, filius temperamenti Cholerici, annorum 25, jam ante annos quindecim festo *S. Stephani* statim post cœnam, adeo male toto in corpore se habuit, ut nullibi se continere potuerit. Anxietas cordis erat tanta, ut, nisi per Vomitus ingentem levatus fuisset, suffocari sibi videretur. Hora post vomitum unica præterlapsa melius agebat, at per totum trium mensium decursum valde tristis & melancholicus, interdum etiam quasi terrore percussus evadebat. Elapso hoc tempore, primò saltim per unum fere momentum vocem & loquelam, quam prius accurate

ratè callebat, amisit, ut ne verbum quidem, neque ullam vocem emittere posset. Quotiescunq; verò loquela amittebatur, toties tum, (quod tamen ultra dimidium annum non duravit) è ventriculo, aliquid fursum, fauces versus reperi sentiebat. Atq; uti primùm vocis & linguæ suppressio saltē momentanea, sic eadem postindies indiesq; crescere incipiebat, ita ut a momento ad semihorium totum, duas, tres, & ultimò ad 23 Horas, inordinatè tamen, duraverit. Tandem typum adeo constantem habebat locutionis restauratio, ut jam per 14 annos, non nisi singulis diebus ab hora 12 meridiana, per horæ integræ spatium, ad primum scil. Pomeridianæ punctum usque loqui possit. Nec falli potest hominis Horologicus sensus horarum transpositione, cum vel nullis campanis sonantibus terminum horæ duodecimæ usque ad primam semper & quam accuratissimè observet. Notandum etiam quod dum loqui potest patiens, aliquantisper balbutiat, quin & tum extra tum intra locutionis tempus linguam ipsam non satis volubiliter queat movere. Præter amissionem vocis & loquelæ nulla de actione queritur, sensus tum interni tum externi sunt integri. Accuratissimè semper audit, unde vel gestibus vel literis (scribere enim scit satis intelligenter, ut ipsum hoc imitatione expressum propria manuscriptum testatur nomen *Georg Ulgryer Jesingus*) ad interrogata cuivis quantum possibile est respondet. Vixit aliàs hactenus omnimodò sanus, nec ullum morbum, excepta Febri, qua ante tres menses vexabatur, quotidiana; cujus paroxysmum inordinatè jam mane, vespere, jam etiam noctu sustinuit, passus est; neque typus amissæ loquelæ ex Febri minimùm mutatus. Vivit etiamnum post febrem sanus omninò & incolumis. Hucusq; Casus Muti periodicè loquentis.

*Mr. PIGOT in his Letter to Dr. HOOK,
from Oxford, Nov. 26. 1681. saith,*

MR. Caswel, in his *Travels with Mr. Adams,* observed Lidford-Bridge, in or about Dartmore in Devonshire, whose Plane is level with the Ground, yet 59 Feet above the Water, that runs swiftly under it.

At Droitwych in Worcestershire, he visited the Salt-Springs, which he found, upon Taste, to be far salter than the Sea. They have three in the Town, close by a fresh River Side, and could have more, but that the Merchants will not permit any more, to keep up the Trade. He tells me, the poor dirty Women, that work at the Salt-Houses, are never troubled with Lice, Fleas, or Flies.



*Mr. Leewenhoeck's Letter in Nov. 1681, of
the Structure of Hair ; of the Excre-
ments, &c.*

S I R,

I HAVE shewed that the *Cortex* of the Hair of an Elard Hart, &c. was compos'd of Globules. I found the same of my own Hair. I have since found it like the Bark of a Tree of Globules, but irregular from the squeezing of the Hair. The Substance of the Hair is made of Threads ; some judge the Hair hollow, others to have Marrow ; but viewing a Hog's Hair, I found the Hollowness of those Hairs from Cleft. Hair grows by Protrusion, not as Plants, being thrust continually forward, from within the Skin outward ; what was within moist, expos'd to the Air, dries and shrinks, and the outward Skin hardening, the inward Threads, upon shrinking, cleave into one or more Clefts, which seems like Marrow. In a Piece of Hog's Hair the Threads appear plain, even in a common Microscope, but bigger in Proportion to the Circumference for Ease ; the Threads were but few, from the Roughness of the Razor. By these may appear their Mistake, who assert Hairs round ; 'tis rather true, they have all differing Figures. A Friend visiting me after a Fit of Sickness, whereby he had lost all his Hair, complain'd of a great Itching all over his Skin, yet his Stomach was good, which the Doctor attributed to a Sharpness of Blood ; which I rather ascribed to the filling of the Body, and from the new growing of the Hair in the Pores, whence it had fallen by his Disease, the Pores of which being closed, the new Hairs, thrusting against the *Cuticula*, caused the Itching. I myself have been so troubled in the Spring,
which,

which, I conceive, to proceed from the same Cause, being my self hairy, and shedding them yearly, as, I conceive, most Men do ; this I observed in two Parts of my Body, also in three Places of my Hand, where I have shorn off the Hair, and found, that some Hairs grew, others not ; some fell out, and I could pull them out without Pain ; also, that these, which fall out, have thin sharp Roots ; those which stay, thick ; also such, as have no Hairs on their Body, have Pores, and an issuing Matter, not so fit for Hair. This appears like black Specks, and are supposed Worms ; and some Doctors of *Aken*, did prescribe this Man to stand with his Back to a Fire made of Oak, and anoint his Body with Honey, that by Means of the Sweetness and Warmth, the Worms may come out, and so be cut off with a Razor, as the Gentleman Patient himself told me ; hereupon I try'd to press, both out of my own, and out of another Man's Nose, these supposed Worms, which seem'd, from their Shape, much to favour the Opinion, seeming to have a Head which proceeded from that Part of the Hair, which was next the Air, it being browner than that within the Skin, but no two like one another. I observ'd all its Parts, but found nothing like an Animal ; but in several I found small Pieces of Hair, some 25, others 100 Times thinner than a common Hair. Hence I concluded, the supposed Animals are only the Places of those Hairs fill'd with the usual Food of Hairs ; my Opinion is confirm'd by new-born Children, over-grown with Hairs, which, I suppose, from too much Nourishment, grow hairy, but when they want that Supply, the Hairs fall out, and grow not again.

In a Looseness I view'd my own Excrements, and took notice of what I eat and drank ; it consisted of clear, yellow, roundish, irregular Particles, also of vast Quantities

Quantities of Globules, like those of Blood, fix together equal to $\frac{1}{3}$ of the whole; others but $\frac{1}{12}$ of a Blood Globule: These I found in a transparent Liquor, in which were many Animals, as big as a Globule of Blood, their Bodies oblong and flat, with many Feet underneath, with which they moved quick; like a Piss-a-bed against a Wall, tho' they moved their Paws quick, yet they went but slow. Once I found but one in the Bigness of a Sand, at other Times, 4, 5, 6, 7, or 8. I have seen other shap'd Animals, (but of the same Bigness) like River Eels; these were very numerous, and so small, that 5 or 600, extended in Length, would not reach the Length of a River Eel; these wriggled like a Snake, very quick, like a Pike shooting through the Water. At another Time, I saw Multitudes, 200 Times less than a Blood Globule, the *Axes* being about one to six, and I am confident, I have seen above 1000 living Animals, in the Bigness of a Sand, swiftly moving, and of three or four several Sorts. Some have thought, these Animals might pass into the Blood; but, I conceive, the Passages of the Blood are so small, that though the Animals were 1000 Times less, they could not pass. My ordinary Excrements, mixed with a clear Liquor, had no Animals; but when thinner than ordinary, it had. I found also Parts of the Food I had eaten, undigested, as the Pipes of Asparagus, the softer Parts being digested.

THIS Summer, in our Meadows, I have observed the Dung of Cows, Horses, &c. fresh, but found no Animals. It consisted of Multitudes of Globules, some $\frac{1}{2}$, others $\frac{1}{12}$ of a Blood Globule, in a clear Liquor. In *May* last, riding my Mare hard, I observed the last thick Part of her Urine, and found, the thick Ash Colour of it was caused by a great Variety of differing Globules, some as
big

big as those of Blood, and these composed of six. The first of these were like a close-grown Bunch of Grapes, and though not perfect round, yet I call them Globules.

*Dr. HOOK's Letter to Dr. TRAPHAM,
of Enquiries for Jamaica, Feb. 18. 1681.*

S I R,

IT will be a great Obligation to the *Royal Society*, if Dr. *Trapham*, or any other ingenious and knowing Person in *Jamaica*, will please to communicate any curious Observations they shall make, concerning any Part of Nature; as concerning the Temperature and Qualities of the Air, the Seasons, Winds, Storms, Hurricanes, Rains, Hails, Dews, Mists, Fogs, &c. the Heats, Colds, &c. of the Seasons; the Qualities of Springs, Rivers, Lakes, &c. the Description of any of the Animals, Birds, Beasts, Fishes, Serpents, Insects, or of any of their Qualities or Uses, for Food, Physick, Pleasure, &c. The Description of their Vegetables; as of their Herbs and Shrubs, whether of the Land or Sea; of the Trees; their Use in Food, Physick, Building, Dying, Perfuming, Firing, Joinery, Turning, Bows, &c. The Description of any of their peculiar Stones, Minerals, Ores, Metals, Clays, Earths, Sands, &c. of what Nature, what Use made of them, &c. Also to inform them concerning any accurate Observations, that have been made of any Eclipses of the Moon, and particularly that of the 11th of this Instant *February*; of the Variation of the magnetick Needle, from the Meridian, or North Point; of the Times of the Tides, both Spring and Neap, and of the Height

Height it rises; of the Currents, what, when, which Way; of the Depths and Soundings of the Seas thereabouts, and whatever of this Kind shall be communicated; or if any curious Jewels, Shells, Seeds, &c. shall be sent, the Society will not only pay the Charge of Freight, but any other way gratefully acknowledge the Favour that the Communicator shall desire, either by recording it in their Registers, or publishing it in their Histories.

Mr. Lewenhoeck's Letter to Mr. Oldenburg, receiv'd from Dr. Crowe, Aug. 14. 1682. Of the Fibres of the Muscles, Dura Mater, Brain, and Moxa.

Excellentissime ac Eruditissime Vir.

GRATISSIMAS, præteritæ mensis decima prima ad me datas, literas accepi, in quibus humanitatem Nobilitatis Vestræ, dominorumque philosophorum visam, grato animo agnosco.

IN literis 22da Februarii scriptis, nobilitas vestra inquit, amicorum quosdam optare, ut summa cum exactitudine observarem fibras musculorum carneas, ut & corticem, medullamque cerebri.

IN literis meis, Anno 1674. prima Junii datis, dixi: Fibras musculorum carneas ex valdè parvis consistere globulis: Sed quo nobilitati vestræ reliquisq; amicis magis satisfaciam, omnes præcedentes meas observationes rejeci, firmiterque proposui, de novo, clarè ac perspicuè eas, oculis meis mihi perspiciendas, sumere.

INTER alias, *carnem vaccinam* accepi, quam, acutissimo cultello, in frusta concisam, per microscopium à membranulis suis separavi, quo peracto, tum primum mihi nudè ac dilucidè apparuit, tenuissima illa membranula, cui fibræ carneæ quasi involutæ, aut intextæ jacent, cujus etiam *Anno 1674. prima Junii* in literis meis memini, dicens: Membranulas illas ex tot striis ac fibris consistere, quasi nudo oculo omentum alicujus bestię aspiceremus. Easdem membranulas jam propius observans, totas illas solummodo consistere ex fibris transversim inter se mixtis, compari, quarum quædam, in oculò meo, decies, vicies, & tenuissimæ quinquagies tenuiores pilo. Cogitabam, num quædam crassioris generis, quæ in ramos se dispergebant, non essent vasa lymphatica.

SUBLATIS, à prædictis fibris carneis, prænomminatis membranulis, eas nudè ac perspicuè vidi, quæ in hac carne erant ad crassitiem communis capilli. Ubi spissæ ac densæ, rubicundæ erant; ubi tenues ac dispersæ jacebant, magis apparebant pellucidæ.

VARIA observandi methodo usus sum, particulas carnearum harum fibrarum videndi, perpetuoq; inveni, eas ex talibus compositas partibus, quibus aliam quam globulorum figuram appropriare nequeo. Imo & minima fibrarum carnearum frustula, grano arenæ aliquoties minora, coram visu meo in plurimas divisi partes. Præterea etiam observavi, carne adhuc recenti & humidâ, quod, tum compressis vel fricatis carnis globulis, illi globuli resolvantur & jungantur, quasi oleaginofam, vel aliquo modo concretam, videremus, materiam aquosam.

HI globuli, ex quibus fibras carneas consistere dixi, adeo exigui sunt, ut (juxta oculum, meumq; visum, judicium ferens) dicam 1000000 non confecturos

fecturos unici arenæ grani, aliquo modo grandioris, quantitatem.

Et quamvis in mentem veniat, me antea Nobilitati Vestræ scripsisse, particulas, ex quibus caro, adeps, ossa, capilli, &c. consistunt (quæ a me globuli vocantur) non esse veros & propriè sic dictos globulos, sed figurâ globulis proximos, eadem tamen hic repetam: Ex. gr. Imaginetur quis sibi, se magnam vesicarum ovinarum, vel aliarum, aquâ repletarum habere quantitatem: Hæ vesicæ quamdiu, ab omni parte, ab aere circumdantur, rotundæ erunt: Sed imaginemur nobis, eas promiscuè & indiscriminatim in vas aliquod injici: Quo factò, vesicæ, globosam, quam in aëre habuerant, rotunditatem, non servabunt, sed a se invicem compressæ, nullum vacuum (sic loquendo) locum relinquent: Et sic quævis vesica aliam, ob flexibilem suam mollitiem, accipiet figuram. Sed quæ in vase supremæ jacebunt, in quantum ab aëre amplectuntur, globosam retinebunt rotunditatem: Idem de globulis carnis, propter eorum mollitiem, sit judicium.

Piam Matrem observavi, comperique membranam hanc, variis sanguinis vasibus intertextam, præter ea quæ nudo oculo, cerebro injacere, cernere possumus, (præcipue separatione Piæ Matris & cerebri facta,) & inter ea venæ admirandæ & incredibilis tenuitatis: Et quantum dijudicare possum, membrana illa ex admodum exilibus consistit fibris. Ulterius vidi, prædictas multiplices venas, per membranam hanc dispersas, ramos suos per cerebri substantiam quoque dispergere: Eo modo, ac si nobis imaginaremur diversas & superficiei terræ palmitibus suis injacentes vites (quas venis Piæ Matris comparo) easque ubique ex palmitibus suis radices, in plurimos dispersas ramos, alte in terra egisse. Terram hic mihi imaginor substantiam

stantiam cerebri, & radices, venas per cerebri substantiam disperfas.

ACCEDENS jam ad partes ipsius cerebri, adhuc affirmarem, id, præcipue ubi paululum compressum ac compactum, non nisi ex globulis, & non ex aliis consistere partibus: Sed ubi rarum ac tenue, cultro concisum aut separatum, sese ostendebat dilucidissima materia, quasi oleum fuisset, quam videns imaginabar mihi cultro id causatum, globulosq; cerebri disruptos aut fractos. Verum enimvero perseverans in observando, non tantum bestiarum, sed & piscium, & præcipue quidem Aselli majoris cerebrum, clare perspexi materiam illam oleaginosam, non fuisse cultro ex disruptione globulorum causatam, sed reverà esse materiam separatam, cui prædicti cerebri globuli quasi injacebant. Ulterius vidi, sed clarissimè in cerebro Aselli majoris, prædictam oleaginosam substantiam, reapse etiam ex globulis, sed multo minoribus, quam ipsius cerebri, consistere.

PRIMO nominati globuli cerebri, meo judicio, circumcirca, globulis sanguini ruborem afferentibus (ex quibus sanguinem consistere dixi) magnitudine æquales sunt. Hi majores globuli, ex maxima parte cerebrum constituentes, respectu globulorum sanguinis, valde irregulares vel inequales existunt. Hujus rationem existimo vel globulorum firmam inter se, aut cum vasibus conjunctionem, vel eorum mollitiem, adeo ut se separari non sinant, quin (sic loquendo) a se invicem discerpantur, ubi e contra globuli sanguinis in fluidiori materia moventur, & propterea etiam, globosam suam rotunditatem, quando in latiori spatio existunt, retinent.

IN animum subit, me antea temporis observasse cerebrum *Anatis*, & tum judicasse, cerebrum ex parte consistere ex filis, aut admodum exilibus vasibus

vasibus. His filis vel vasibus postea mihi sæpius occurrentibus, tum temporis & idem judicabam, ea tantum produci per firmissimam globulorum (ex quibus cerebrum solummodo consistere putabam) inter se unionem, & qui minima extensione sic in fila mutarentur. Sed observationes meas per integrum mensem continuans, clare admodum vidi, multiplices valde, & supra modum exiguas venas (de quibus antea certus esse non poteram) eas in bestiarum cerebro existere, & revera venas esse, licet cognitu admodum difficiles. Verum observante, exactiusque inspiciente me Aselli majoris cerebrum, multiplicia illa minima vasa, aut venulas, quæ supra modum pellucidæ, clare mihi ostendi: & multas, licet in ramos dispersas, & quindecies vel vigesies filo bombycis exiliores, tamen cognoscere potui: Horum dictorum vasorum vel venarum maximam multitudinem, in quantitate cerebri ad magnitudinem arenæ, vidi: Præterea & vasa sanguine repleta, vel quærubicunda apparebant, ut etiam vasa ad crassitiem unici fili bombycis, & insuper pellucida vidi.

H A S C E meas observationes circa bestiarum cerebrum persequens, vasa ante nominata, admodum perspicue quoque ostendere potui, eaque summa cum admiratione vidi, partim ob ingentem multitudinem, partim ob supra modum summam eorum exilitatem. Si enim juxta oculum meum judicium feram, dicere teneor, quod, si globulus, sanguini ruborem afferens, in octo esset divisus partes, & unaquæque octava pars esset firma & solida, ne una quidem harum partium hæc vasa transire posset. Et quamvis diversis vicibus prædicta cerebri vascula mihi perspicue ob oculos posueram, in observationibus meis circa illa tamen continuavi, & quo penitius ac sæpius observarem, eo exactius admodum multiplicia illa vascula, cum ipforum ramis (qui adeo infirmi ac debiles, ut minima contractione disrumperentur) dignoscere potui.

INTER dictos globulos, ex quibus cerebrum ex parte consistit, globulos sanguinis jacentes vidi, qui, ob perfectam rotunditatem, clare a globulis cerebri distingui ac dignosci poterant : hos sanguinis globulos opinabar e sanguinis vasibus per cerebrum dispersis, & cultro concisis, effluxisse.

INTER corticem & medullam cerebri, aut parvam, aut nullam fere, differentiam, observare queo : præsertim cum paululum rariorem, & tenuiorem, eam mihi videndam fumo : tantum dicam, venas, aut vasa corticem cerebri permeantia, aliquo modo subfusi vel subnigri esse coloris, ubi e contra vasa medullæ cerebri erant dilucida ac pellucidiora.

IN cerebro, sed plerumque in cortice, tam exiles ac rubicundas, ex majoribus procedentes, venulas vidi, ut capere nequeam, quomodo globuli sanguinis eas permeare possint : & ultra, quo pacto globuli paulo rariores, & separatim observati, ferme nullius saltem admodum modici essent coloris, ubi e contra sanguis in hisce vasibus ruberet. Imo & per ipsas venas, in substantiam cerebri proximam, color ille rubicundus penetrarat, eamque infecerat. Sed animo revolvens, me in observandis Pediculis sæpe vidisse, quando Pediculum esurire feceram, ipsique prope fame confecto, jam sanguinem fugendum darem, ipsum non potuisse consumere sanguinem, aut etiam ejicere ; quo evenit, ut globuli sanguinis rubicundi liquefierent, & in materiam fluidiorem resolverentur, & sic per totum Pediculi corpus, imo per ipsas ungulas & cornua dispergerentur, omnibusque partibus ruborem afferrent. Causam non consumpti sanguinis opinabar, intestini aut parvarum in Pediculo venarum exsiccationem, defectu alimenti causatam : quo debitus ac ordinarius sanguinis motus fuit impeditus, nec justo modo per totum corpus vehi potuit. Sed memini, hanc sanguinis mutationem, in sanguine, in vitro per aliquod tempus, servato, aliquando etiam a me observatam.

Et idem in parvis cerebri venis accidere posse opinor (quamvis adeo exiguæ sint, ut globulus, rotunditatem servans, penetrare nequeat) ut resolutis globulis, & venæ rubræ appareant, & cerebrum adiacens rubore tingatur.

MEDULLAM spinalem Vituli, Ovis, Gallinæ, ac Afelli majoris etiam observavi, quam ex iisdem cum cerebro partibus consistere comperi, cum hac solummodo differentia, quod præter globulos, quos cum cerebro spina medulla communes habet, in hac ingens globulorum oleaginosorum & pellucidorum numerus, ac diversæ magnitudinis jaceret. Quidam enim quinquagies majores reliquis, ac præterea admodum molles, ac fluidi. Cæterum medullæ spinales multis ac supra modum tenuibus instructi erant venis aut vasibus. Præterea hic per medullam spinalem dispersæ erant fibræ coloris subfusci, & ad crassitiem capilli, quædam vero tenuiores: quibus visis imaginabar mihi in initio, num quævis fibra forsan non esset vena: sed summa cum exactitudine penitus inspiciens atque observans, comperi, quamvis fibram non esse vas, sed singulas earum consistere ex aliis valde exiguis fibris aut vasibus sibi invicem adjacentibus, inter quas fibras pellucidissima videre erant vasa ad crassitiem fili bombycis. Hic tum opinabar, an hæc vasa non essent ea, quæ spiritibus animalibus per medullam spinalem vehendis inserviunt.

Hæc sunt, clarissime ac nobilissime vir, quæ post ultimos, indefessos, & exactissimos labores, huc dum in cerebro, &c. detegere valui.

UT I dixi antea, quo pacto multæ venæ sibi invicem adjacent conjunctæ quasi una tantum essent vena, sic illud mihi non tantum occurrit in medulla spinali, & interdum quoque in cortice cerebri: Verum etiam in fructibus, & seminibus, præsertim in Castanearum venis. Ut & in cortice & putamine

tamine Amygdali: in secunda nigri piperis membrana; In putamine Avellanæ nucis duro, & membrana quæ intus in concavo ei adhæret, & in molli cortice cui nucleus injacet involutus: ubi quidem 15 aut 20 tenuissima vasa sibi invicem adjacentia vidi. Etiam in membrana nucleum Juglandis immediate amplectens. Omnia hæc vasa ex continuata tortuositate composita sunt, eo modo ac si nobis imaginaremur tenuissimum aliquod filum æreum aut ferreum crassiori pressim circumvolutum (in formam qua fustis vel baculus fissus iterum fune colligatur) postea extracto crassiori filo, tenuissimum illud quod ei circumvolutum fuerat, omnes gyros ac circumvolutiones retinebat. Eodem modo (ut dixi) tenuissima in prænominatis feminibus & fructibus vasa contorta vidi. Præterea in Malo & Piro tenuissima sibi invicem adjacentia vasa observavi.

ANNUS jam præteriit, cum in ædibus suis, nobilis dominus Constantinus Hugenus a Zulichem, mihi monstraret *Moxam*, addens, quo pacto inustione istius herbæ podagra sanaretur: Aliquantulum hujus sic dictæ herbæ Moxæ mecum domum retuli, carpoque manus impositum juxta præscriptum urendi modum, combussi (ex curiositate nimia, nam podagra non divexor) quo extraordinariam hujus combustionis effectum detegerem, observavi autem cuti, in loco ustionis, injacere materiam flavam ac oleaginosam, quam principio judicabam pec combustionem cutis causatam. Verum hanc cutis inustionem intermittere coactus fui, non ob dolorem, sed sanationis difficultatem: si enim tam facile sanare possem, ac vulnus ex incisione cultri, (quod colligatum ac confutum sanatum æstimo) sæpius hanc inustionem iterarem. Per microscopium Moxam examinavi, firmiterque sentio Moxam non esse herbam ex optimæ terræ pharmacis artificiose paratam, ut autumat dominus Busschoff in tractatu de Moxa p. 52 sed solummodo vaporem

porem aliquem ejectitium alicujus fructus, sicuti in malis Persicis, Cydoniis &c. lanosam videmus substantiam cortici adhærentem. Cogitaram etiam me de fructibus quibusdam collecturum herbas moxæ quodam modo similes, sed hucusque efficere non potui.

MOXA, quoad figuram, gossypio respondet: sicuti enim inter pilos, capillosve, & lanam, nulla, nisi quoad crassitiem & longitudinem, differentia, utpote ex globulis consistentes, & ad rotunditatem inclinantes: æque parva inter moxam & gossypium differentia, & illa & hoc enim duobus planis gaudent lateribus. Eandem figuram, lanosum illud quod interne rubri corticis castaneæ convexo adglutinatum, ostendit: in hoc tantum differens, quod moxa multo subtilior sit gossypio, hoc castaneæ lanositate. Moxam, cum inustio manus non placeret, juxta & gossypium, forfice parumper dissectum, quo facilius ignem perciperet, chartæ angustæ imposui, & hæc moxæ & gossypii combustio sibi invicem exacte respondebant, adeo ut mecum statuam, si inustio quendam, circa sanationem podagræ, producat effectum, illud non evenire per aliquam moxæ propriam qualitatem, sed tantum per inustionem ipsam, & si gossypio inustionem faceremus, nos tantum effecturos quantum moxa.

ULTERIUS moxæ, gossypii & lanositatis castaneæ æqualem sumsi quantitatem, quam juxta se invicem posita combusti, comperique quodvis horum trium post se reliquisse materiam aliquam oleaginosam, sed moxa plurimam; causam imaginabar, quod, quamvis quantitas moxæ quoad oculum non major, revera plus materiæ esset in moxa, utpote quæ subtilior molliorque, gossypio arctius junctas haberet partes, & propterea majorem olei quantitatem post combustionem reliquerat. Adeo ut credam dominum Bisschoff a Chinesibus moxæ qualitates, præparationemque extollentibus, esse seductum ac deceptum.

ETIAM

74 *Of the Fibres of the Muscles, &c.*

ETIAM animo recolens commune chirurgorum dictum, gossypium (ut Holl. dicitur) esse ignitum, hoc est, inflammationem causare, & noxam afferre vulneribus, quando iis colligandis applicatur. Malignitatem, gossypio adscriptam, in hoc consistere judico, viz. quod, ut antea dictum, duo plana, & per consequens quævis particula, duo acuta habeat latera. Hæc acuta latera tenuiora, subtiliora & duriora globulis fibrarum carnis, propterea (cum gossypium vulneribus applicatur) non tantum caro adhuc sana, sed materia incarnationi novæ inferviens, & molliores carne sana globulos habens, vulneratur ac læditur imo conciditur & resolvitur. Sed contrarium cum linteo evenit, utpote cujus partes rotundæ & arcte sibi invicem junctæ, majus corpus efficiunt, ideoque globulos carnis & materiæ incarnationi inservientis tam facile non, aut in totum non lædunt.

HÆC sunt, nobilis vir, quæ excellentiæ vestræ dominisque philosophis hac vice per literas nunciare volui: Submisse & subnixè rogans, nobilitas vestra velit dominis philosophis multam meo dicere nomine salutem, dataque occasione, rescripto, has bene perlatas, & quo pacto hæ meæ observationes aut convenient cum antecedentibus, aut in quantum (si) ab illis discrepent, significare. Nunquam occasionem deero, qua demonstrare poterò

Excellentissime Clarissime Vir,

Quod Sim Nobilitatis Vestræ

Addictissimus Cultor,

Subsignaverat

ANTHONIUS LEWENHOECK.

*Dr. John Carte's Letter to Dr. Hook, of
Worms like Millepedes, in the Stomach,
&c.*

S I R,

I SEND you the following Case, which, in some of its Circumstances, is not very common : A Girl about eight Years old, who has never been very healthful, but of late hath looked more pale than ordinary, and troubled with Pain at her Stomach, yesterday, upon taking a purging Powder, vomited a Sort of Insects, to the Number of about a Hundred, very much resembling little *Millepedes* ; I saw some of them, and three, that were living, I put in a Box, and a little Dust to them, but they followed the Fate of the rest, and died presently ; I have sent you six of them. The Child had taken Worm-Seed over Night, but had a very troublesome Night, could scarce be held a Bed, complaining both of the Pain and Soreness of her Belly, fancying the Worms had eaten it thin in one Place, and would eat a Hole in it. The Length of one of the biggest, (though there was but little Difference) was $\frac{1}{5}$ of an Inch : I view'd them through a small Microscope, which did not represent them so clearly, as to distinguish them from the common Wood-Lice, only their Bellies were more transparent, and their Heads of a more confused Figure, which last I thought afterwards might be caused by the rowing up of the *Antennæ* or Horns, which I observed some of the common *Millepedes* to do, when they die. That among them which was black, was accidentally so, by dropping a little Ink upon it.

THE Child, after her vomiting, had a Stool, in which were several very small white Worms, about an Inch long, which are not uncommon, but
shews

shews that the *primæ viæ* abounded with such putrid Humours, as are usually productive of a verminous Brood : She is now very hearty, and eats her Meat well, and free from all the former Symptoms.

I HAVE heard some Stories of the like Nature, but am not forwards to relate them, because they totally depend on the Credit of others : One Man I know, who, many Years ago, was reduced to a thin consumptive Habit, and, upon taking *Mercurius Dulcis*, voided by Stool an incredible Number, or rather Quantity, of small Animals, which (according to the Description I had of them) were less than these, and of a rounder Figure.

If these were bred in a *Folliculus* of their own, that Part must apostemate, and so a purulent Matter be evacuated with them ; but I rather think, they must be generated in the common Passage, and I remember I have often seen Abundance of Animals bred in humane Excrements, but was not so curious to observe their Figure.

It is hard to imagine, how Worms should live in the Stomach, amidst that acid Humour, which, whether it be the Cause or Effect of Digestion, has the Force of a *Menstruum* ; but it must be supposed, that in such Bodies, the Ferment is alter'd, if not destroy'd : You observe lately, that Birds are very industrious to kill Insects before they eat them ; I am apt to think, if they pass'd immediately into the Gizzard, there was no Need of killing them first ; but the *Ingluvies* supplying the Want of Teeth, and only macerating what other Creatures chew, has no Acidity that would offend them.

A Letter from Mr. J. YONGE, &c. 77

S I R, I write this Account hastily, because I would have you see them as soon as might be.

*Manchester,
August 25,
1682.*

I am,

S I R,

Your humble Servant,

J. CARTE.

N. B. *The Child had not taken any Millepedes, nor uses to eat Earth or Dirt, which I have known some distemper'd Children do.*

A Letter from Mr. J. YONGE, to Dr. HOOK, of divers curious Matters observ'd by him.

A WOMAN, about 36 Years old, had from her Childhood been sickly, more especially tormented in her Belly with a Pain, accompanied at first, every three Months, and afterward every three Weeks, with a round Swelling like her Fist, in her left *Hypocondria*, sensibly moving to and fro', and plainly to be felt: Horrid Pain would then deprive her of Senses, twelve or twenty-four Hours; and then she would recover again, be without Pain, and the Tumour vanish, without being followed by any Evacuation, of either Wind, Water, Excrement, &c.

THOSE Paroxysms, for many Years, kept a due Course of three Weeks; she was generally costive, found that Milk irritated her Pain, that Flesh and all salt Meats disagreed with her.

NOTWITHSTANDING this, she married about twelve Years since, and had one Child. During her Breeding, her Pains observ'd the Course, and abated nothing of their Vehemence, which equall'd, if not exceeded that of Child-birth.

UNDER this Plague she liv'd, till about *February*, 1680, the Pain seem'd fix'd on the left Side, on the Region of the Spleen, and seem'd as if proceeded from the Lodging of some heavy Thing, and begot such Pain, as she could not lie down in her Bed. Thus she continued in a miserable Condition, using Purges, Clysters, &c. which were advised by charitable People, she being very poor. The 15th of *November*, 1681, she became quit of all the Pain in her Side, and then felt somewhat to burthen, and, as it were, stop the *Intestinum Rectum*, causing frequent Motions to Stool, but no Evacuation, but a little Slime like a *Tenesmus*. The Suppression of her Evacuations that Way, for six Days, so press'd on some of the urinary Channels, that her Urine also stopp'd. In this doleful Condition, she sent for me, when, giving me the abovesaid History, I guess'd somewhat extraordinary must be in the *Rectum*. Accordingly, examining by a Probe, I felt a hard Substance like a Stone, which, with a strong Pair of *Forceps*, I extracted, and then cleansed out the Bowels with a Clyster; she remained void of any Pain, and is so to this Day.

THE Thing extracted, was of a round Figure, somewhat oblong, with some Depressions, such as a Man's Fingers make on Pitch, Plaister, or Wax. In Weight, was one Ounce and a Quarter; was five Inches round, swam on Water, though seem'd a Stone. Its Outside was black as Jet, smooth as Varnish, but no thicker than a Man's Skin; next to it, it was stony, or gritty, like Brick, the Thickness of half a Crown. After some Months, I
cut

cut it in two with a Hatchet, and found that next to the gritty Shell, it was full of a woolly, hard Substance, like rotten Rags, or Sponge, or chew'd brown Paper, within which, lay a Lump of the Bigness and Form of a small Prune. Cutting that in two also, I found it a Prune, or Plum indeed, the Pulp of which was dry, and hard as Paste-board, as was the Kernel in the Shell, that lay in the Middle of it.

WHENCE it's manifest, that all these Accidents, that had so long molested this poor Woman, proceeded from this Plum, or Prune, swallowed above thirty Years before; which, probably, stuck in some folding of a Gut, or a Cavern, or Cell of the *Colon*, increasing its Dimensions by the Adhesion of new Matter, till (no one knoweth how) it tumbled down to the *Rectum*, and I drew it forth. But how the Surface became petrify'd, and so uneven, and varnish'd over with a black smooth Matter, is to me a Wonder.

BEFORE I broke it, I thought it might be a Gall-Stone, (tho' she never had the Jaundice) having lately seen a Gentlewoman, almost dead in that Disease relieved by the Evacuation of one, almost as big as a Pullet's Egg, and another from a Man, as big as a Nutmeg. Both followed (tho' costive before) with a Lask, discharging prodigious Quantities of Choler. The Authors are innumerable, that mention this latter Sort, though I meet none so great, *Vide La. Riverius Obs. ab Henrico Ruffeo com. obs. 4. Tho. Bartholin Acta Med. A. 71, 72. obs. 100. J. Fernelius lib. 6. de part. Morb. & Sympt. J. Skenckius, Obs. Med. Sennertus, &c.* But few speak of any, that appear generated in the Guts, *Vide Miscel. Curiosa vol 6. obs. 20.*

T H E R E

THERE lately died, in *Cornwall*, a Woman of about 154 Years of Age; I have employ'd a Friend to give me a particular Account of her Manner of living, &c. which I will not fail to transmit to your Hands.

HERE was lately, also, an Ewe kill'd, that had a full grown Lamb lapp'd up in the *Omentum*, among the Guts, without the Womb; questionless it was a Conception in *tuba Fallopiana*, which, when growing big, broke forth into the Bowels. But that the *Pedunculus* should hold, and where the *Placenta* was fastened, is strange: In the *fundus uteri*, it cou'd not be, and if any where else, how was the nutritious Juices, &c. conveyed to it. It was separated from the *Uterus*, and the Bowels thrown away before I knew it, so that I could not make that Examination: This Accident is not so new, but that Instances of the like are given by *Monf. Bayle*, *Mr. Blegny*, *de Graeff*, *Elſchotius*, *Riolanus*, *Rheynbuse*, &c.

A CHILD was lately heard, by several People, to cry in its Mother's Womb, some Days before the Birth; do not Children then breathe by the Lungs, before they are born?

I find such another Relation (if not the same) of a Lamb in the Omentum, told by Mr. Younge, in the Phil. Transf. Numb. 323.

WILLIAM DERHAM.



Observata quædam Anatomica in Vespertilione dissecto 22 die Sept. 1682. Per T. Molyneux, M. D. Dublinij.

EXTERNAM hujus animalis figuram verbis describere, supervacaneum fore existimavi, utpote cum in hisce nostris regionibus adeo frequens occurrat Vespertilio, ut cuique volenti, eum vivum intueri, facillime obtigit; vel saltem omnibus conceditur, ut illius vivam aspiciant delineationem, cum apud tot varios autores de animalibus scribentes, hoc accurate depictum invenire liceat. Iis igitur omnibus omisiss, quæ alii de Quadrupede hoc volanti jamdudum tradiderunt, solummodo hic notabimus quædam hætenus neglecta & inobservata quæ in illius dissectione nobis videre contigit.

Et primo *Penis* in conspectum venit, insignis quidem magnitudinis, habito respectu ad exiguum animalis corpusculum; in eo *Officulum* hujus figuræ (I.) æmulum delituit, officulum in *Murino* pene contentum longitudine duplo superans.

Testiculos habuit satis amplos, extra abdominis cavitatem prominentes.

Vesiculæ Seminales, ex utroque latere *Vesicæ Urinariæ* sitæ, semine mirum in modum turgidæ conspiciuntur, *Phaseoli* magnitudinem æquantes.

LONGITUDO omnium *Intestinorum*, scilicet a *Pyloro* usque ad anum vixdum 6. pollices æquabat; at in *Mure* dissecto (cujus similitudinem ex omni animalium genere maxime præ se fert.) *Intestinorum* circuitus 21 pollices superavit, nullâ habita ratione illius appendicis intestinum *Cæcum* dictæ, quo omnino caret *Vespertilio*; cujus *Intestinorum* brevitatem, notabilem levitatis gratiâ, a Naturâ constitutam esse opinor, quæ ab hoc Quadrupede, per aerem volitare destinato, quicquid esset oneri provide desumpsit.

Ventriculus, Lien & Renes iisdem partibus in Mure omnino perfimiles sunt; at *Hepar & Pulmones* in duos duntaxat lobos dividuntur.

PENITUS mortuo animale *Cor* motum suum, viz. *Systolen & Diastolen*, amplius horæ spatio peragebat.

Oculi insigni convexitate donantur; eos autem in hunc finem ita fabricatos suspicor, scilicet ut in tenebris videant; quippe per solam noctem & opaca crepuscula prædam suam (*Muscas* scil.) animal hoc infectatur, quas inter volandum *Hirundinis* ad instar captat.

Blasius in sua *Anatome* diversorum animalium, ubi de *Vespertilione* loquitur, hanc controversiam inter quosdam *Medicos* natam, meminit; scil. an *Caudam* habeat; sed de re ipsis sensibus adeo evidenti ortam esse contentionem magnopere admiror, quippe æque bene disputassent, an *Mus* *Caudam* habeat, cum in eo non magis manifestam *offis Coccygis productionem* (quæ in omni animale *Cauda* nominatur) quam in *Vespertilione* aspicere liceat.

ANIMAL est *Viviparum*, & nihil commune ullæ *Volucrum* speciei possidet, exceptis *alis* & robore *Musculorum pectoralium* alas moventium; quippe nec *Bipes* est, nec *Pennatum*, nec *Rostratum*, &c. sicut omnia volantium genera: quomobrem a *Clarissimo Willughbeo*, in suo pereleganti libro de *Avibus*, inter *Aves* nequaquam numeratur, licet alii scriptores *Vespertilionem* inter eos collocare haud dubitaverint.

DUM in vivis esset animal, in *Pixide* lignea incarceratum per spatium quatuordecem dierum aservabam, quo tempore *Muscos* ex omni genere & *Araneas* avidè comedebat: * *Corporis* autem *Situs*

* I have seen him in this Posture asleep, above forty several Times.

tus (quem semper eligebat quoties somnum caperet) singulare quid & insolitum videtur; quippe spreto molli gramine in fundo suæ Caveæ substrato, pixidis lateri adhæreret, & posterioribus suis partibus directe elevatis, anterioribus autem & Capite perpendiculariter deorsum positus, suspensus semper quiesceret: in hac autem insolita positura corpus suum sustentaret *posteriorum pedum* beneficio, quorum uterque quinque digitis, acutissimis unguibus armatis, instructus est, & ab his lignæ pixidis lateri infixis, pondus totius Corporis tuto dependebat; *anteriores* autem *pedes*, unico tantum digito instructi, ad illius sustentationem in hoc situ nequaquam contulerunt.

SI quis hujus animalis *Ostiologiam* cupiat, consulat Cap. 26. Partis Secundæ Anatomix Blasianæ variorum Animalium, & Tabulam 41. ubi Vespertilionis *Skeleton* & *Effigiem* videre licet.



The Rule of False Position, in Dec. 1682.

MULTIPLY the Position by the alternate Errors, and if the Errors be of the same Kind, divide the Difference of the Products, by the Difference of the Errors ; but if they be of divers Kinds, the Sum, by the Sum: And the Quotient, shall give the Number sought.

FOR Demonstration, what Number is that, which being multiply'd by B 3 will produce the Plane B A 30.

Positions.

Let it be $A - C = 6$
into $B = BA - BC = 18$

Positions.

Let it be $A - D = 8$
into $B = BA - BD = 24$

$$A = 10.$$

$$B = 3.$$

$$C = 4.$$

$$D = 2.$$

$$BA = 30.$$

The Errors there ore are.

First Error. $BA \text{ plane} - BA + BC = 12.$

Second Error. $BA \text{ plane} - BA + BD = 6.$

The Less subtracted out of the Greater, there remains,

$$\overset{12}{BC} - \overset{6}{BD} = 6 \text{ the Difference of the Errors.}$$

Which being multiply'd into their altern Errors, the Products will be as follows.

BC Defect

BD Defect

$$\frac{A - D}{BCA - BCD} = 96$$

$$\frac{A - C}{BDA - BCD} = 36$$

And Subtraction a- gain being made } $A = \frac{BCA - BDA}{BC - BD} = \frac{60}{6} = 10$

Again. Data { B
 BA

quæritur A.

Sit $A - C$

Sit $A - D$

in $B = BA - BC.$

in $B = BA - BD$

$BA \text{ pl. } BA + BC$

minus. $BA \text{ pl. } - BA + BD$

Ergo Errores + BC

+ BD

&

$$\frac{A - D}{BCA - BCD}$$

$$\frac{A - C}{BDA + BDC}$$

min.

$$A = \frac{BCA - BDA}{BC - BD}$$

Pos.

Of False Position.

$$\begin{array}{rcl}
 \text{Pos. } A + B & \text{Pos.} & A + C \\
 D & \text{Errors} & E \\
 B \cdot C :: D \cdot E & & \\
 CD = BE & & \\
 AD + CD = AE + BE & & \\
 AD - AE = AD - AE & & \\
 \hline
 \frac{AD - AE}{D - E} = A & &
 \end{array}$$

As the Difference of the Errors to the first Error, so is the Difference of the Positions to a Number, which, contrary to the Sign of the first Error, being added or subtracted to or from the first Position, gives the true Position.

WHEN the Errors have different Signs, their Sum is their Difference.

THE Reason of the Proportion betwixt the two Errors of Position, is, because the Numbers added or subtracted, and apply'd to the one Term of Proportion, are proportionate to the Numbers added or subtracted, and apply'd to the other Term, because two Numbers, apply'd or divided by the same Number, continue the same Proportion. Likewise, if you add or subtract like proportional Parts, the Sums or Differences will be in the same Proportion.

As the Error of the first Position to the Error of the second Position, so is the Error of the first Operation, to the Error of the second Operation. But the Rectangle of the Means, is equal to the Rectangle of the Extreams. Subtract the one, from a Number containing the other, and you leave the true; only in greater Products contain'd so many Times, as the Difference of the lesser Error of Operation is to the greater Error of Operation, because the lesser Error could not take

away so many Truths as the greater Error had made in the greater Product.

| | |
|---|---|
| <p>From BA Take $BA - BC$ <hr/> Remains $BA - BA + BC$</p> | <p>From BA Take $BA - BD$ <hr/> Remains $BA - BA + BD$</p> |
| <p>The Difference $BC - DB$</p> | |
| <p>$A - D$ BC <hr/> $BCA - BCD$</p> | <p>$A - C$ BD <hr/> $BDA - BCD$</p> |
| <p>Subtract $BDA - BCD$ Remains the Diff. $BCA - BDA$</p> | |
| <p>Divide it by $BC - BD$ — Is the true Position (sought)</p> | |



*Dr. HOOK of Earths, Salts, &c.*MARCH, 14, 168 $\frac{2}{3}$.

THE Nature of Clays, Stones, Limes, &c. being discoursed, I mention'd the Sorts of Stone which were here call'd Freestone, viz. such as could be saw'd with a tooth'd Saw, such as *Cone, Rigate, Burford, Ketten, &c.* That Stones were of two Natures, one bituminous, or sulphureous, the other saline and watery; the sulphureous would calcine into Lime, the saline make Glass, vitrify or dissolve, and moulder with the Rain, Air, and Frost. That both these Sorts are often found in the same *Portland-Stone* one Part whereof will moulder, the other harden with the Air. That Loam is a Mixture of various Sorts of Clays and Sands, and may be separated by washing. That such a Material is usually chosen for Brick-Earth, as being most easily softened and tamper'd for moulding, and most easily and speedily dry'd for burning, and most easily burnt; to make it yet more easy for burning, 'tis usually dry, and exposed to the Winter Rains and Frosts, for mellowing against the Spring. That the finest Clay would make the best Bricks, were it not for the more than ordinary Labour and Charge in washing, working, moulding, drying, baking, as is evident in Pottery, and Tiles, and especially in the *Roman* Bricks, which are some of them of so fine an Earth, so well moulded, and so thoroughly burnt, as to last even to this Day, as intire and perfect as when first made, in all probability. That hungry Clay was hardest and best to endure the Fire without melting, but saline, and fine Clays, were most apt to vitrify: And thence the throwing in of three or four Shovels of Salt into

a Pot Furnace when hot, made all the Pots in the Furnace to be glaz'd. That *China* was such an Earth, as was very difficult to be vitrify'd.

CONCERNING Salts, and other volatile and fix'd Bodies, I mention'd, that there were two Sorts, one that was homogenous to the Air, and would be dissolv'd into it. This was call'd Volatile; the other heterogeneous, and would not at all be so dissolv'd and mixed with it; and these were call'd Fixed. Of the Volatile, there are various Sorts, which will be dissolv'd into the Air, by differing Degrees of Heat. Spirit of Wine, or such other fermented Spirits, Camphire, the odorous Gums of Flowers, and Herbs, will be dissolv'd into the Air with a small Degree of Heat; other Bodies more difficultly, and require a stronger and stronger Heat, as they are more and more fixed; so some Salts and Gums, &c. will not rise at all: And these are call'd fixed Bodies, or Alcali Salts. Of these which are dissolv'd into the Air, some are tasted as it were, by the Nose, others not in the same Manner as in Tinctures made in Waters; some, whereof the Tongue does taste, others not.

CONCERNING the *Oxford* Trial by blue Starch, which they affirm'd would turn red, with Acids, I said 'twas impossible, Smalt being Glass, but it must be *Litmus*, or *Indico*: But most likely *Litmus*; being a clear, blue Tincture; but *Indico*, a thick Precipitation.

THE Experiment was very considerable, though plain, giving a further Explanation of Gravity, by making a large Glass vibrate, with a Viol Bow: By which Vibration, a certain Undulation is plainly seen to dart out from all such Places where the Glass vibrates. And it was very plainly visible, that the Water, and Bodies in it, did move towards every such vibrating Part, and from every other Part that was at rest.

*Dr. HOOK's Experiments of the floating of
Lead, &c. July 4, 1683.*

WEDNESDAY, *June 27, 1683*, I shew'd two Experiments to the Society, which succeeded; of which I gave an Account, *Wednesday, July 4, 1683*, as follows.

Of the floating of unmelted Metal, upon the same melted, with the Cause.

I. THERE was melted, in a Crucible, about a Pound and half of Sheet Lead, and whilst it remain'd melted, several small Pieces of the same Lead were gently one by one, by the Help of a *Forceps*, laid upon the clear and bright Surface thereof (the Scum and Litharge being first removed) and it was found that they all swam upon it, and did not sink to the Bottom; but if they were all cover'd or plung'd under the Surface, they would not rise again, but sink to the Bottom, and soon be melted.

THE Occasion of the Experiment, was a Suggestion, that Lead, when it concreted, did (as Water when it congeals to Ice) settle itself into a more rarify'd Texture, than when fluid; by which Means, it became lighter than the melted Lead, and so swam at the Top of it. But though the Effect were answerable to the Assertion, yet the Cause, assign'd, was false; for it was very evident, that the Reason of its swimming, was much the same with that of the swimming of a Needle, or of Water-Spiders, and many other Insects upon the Surface of the Water; namely, a Coherence of the Air to the Surface of the swimming Body; which Coherence of the Air does depress and remove a greater Part of the Fluid, Lead, or Water, than
the

the meer Bulk of the Body itself would do ; which, in both these Cases, is very evident ; and was, in these Trials, very remarkable ; for the Surface of the Lead did plainly bend and sink below its Level, with a Roundness where the Piece of Lead lay ; which bending of the Surface, was made the greater by a thin Plate, or Skin of Litharge . which the Air does presently make upon melted Lead, so soon as ever a former is remov'd or scummed off.

Of the Condensation of Air by Water.

II. T H E R E was stuck into the Side of a Piece of wooden Pipe, for conveying Water, a small cylindrical Pipe of Glass, about a Foot long, and somewhat better than half an Inch in Diameter ; one End of which Pipe was hermetically seal'd, but the other End was open, and communicated with the Cavity of the wooden Pipe, by means of a small Hole bor'd in the Side of that wooden Pipe, into which the open End of the Glass Pipe was thrust hard, having a little Linnen Rag wrapped about it, as is usual for Taps put into the End of a Barrel, or other Vessel. Then (there being about a Foot of Air left in the Glass Pipe) Water was forc'd into the wooden Pipe by a small Force-Pump ; and it was plainly to be seen, that as the Water was more and more strongly forc'd into the wooden Pipe, the Air left in the Glass Pipe, by the Water that enter'd into it by the aforesaid Hole, was condensed into a lesser and lesser Room ; so that hereby, the true Degree of the Pressure of the Water could be easily found and measured ; which was conceiv'd to be an Experiment, or Instrument of great Use for Water-Works, because by means hereof, the Force of Water, in any Pipe, might presently be known ; namely, both from
what

what Height it descended, and to what Height it would there again rise. The Rule of doing which, was the next Day, to be brought in.

Dr. HOOK's two Experiments, shewing the Pressure of Water in Pipes, and how to measure it. Also the Expansion of melted Metals, made before the Royal Society, July 4, 1683.

JULY the 4th, 1683. I read the Accounts of the two Experiments made *June 27*; and likewise further explain'd the Uses of them, by Discourses in other Particulars, namely, that the second Experiment was of great Use for the trying the Strength of Pipes, for Conveyance of Water. By which Means, I have examined several Sorts of earthen and other Pipes and Cements, and have found that earthen Pipes, made of a Material only, as hard as House-Tiles, would endure the Pressure of 100 Foot of Water; that the Use of the other Experiment, was chiefly luciferous, namely, to shew the Nature of Fluids and Congruity, of which I should shortly have Occasion to discourse more at large.

THEN I produced and read the Rule, according to which the Pressure of the Water, in any Pipe, might, by means of a Trial with the former Instrument, be calculated and reduced to certain Measure in Feet and Inches. The Means of performing, I shew'd, were principally two, first Arithmetically, and secondly, Mechanically.

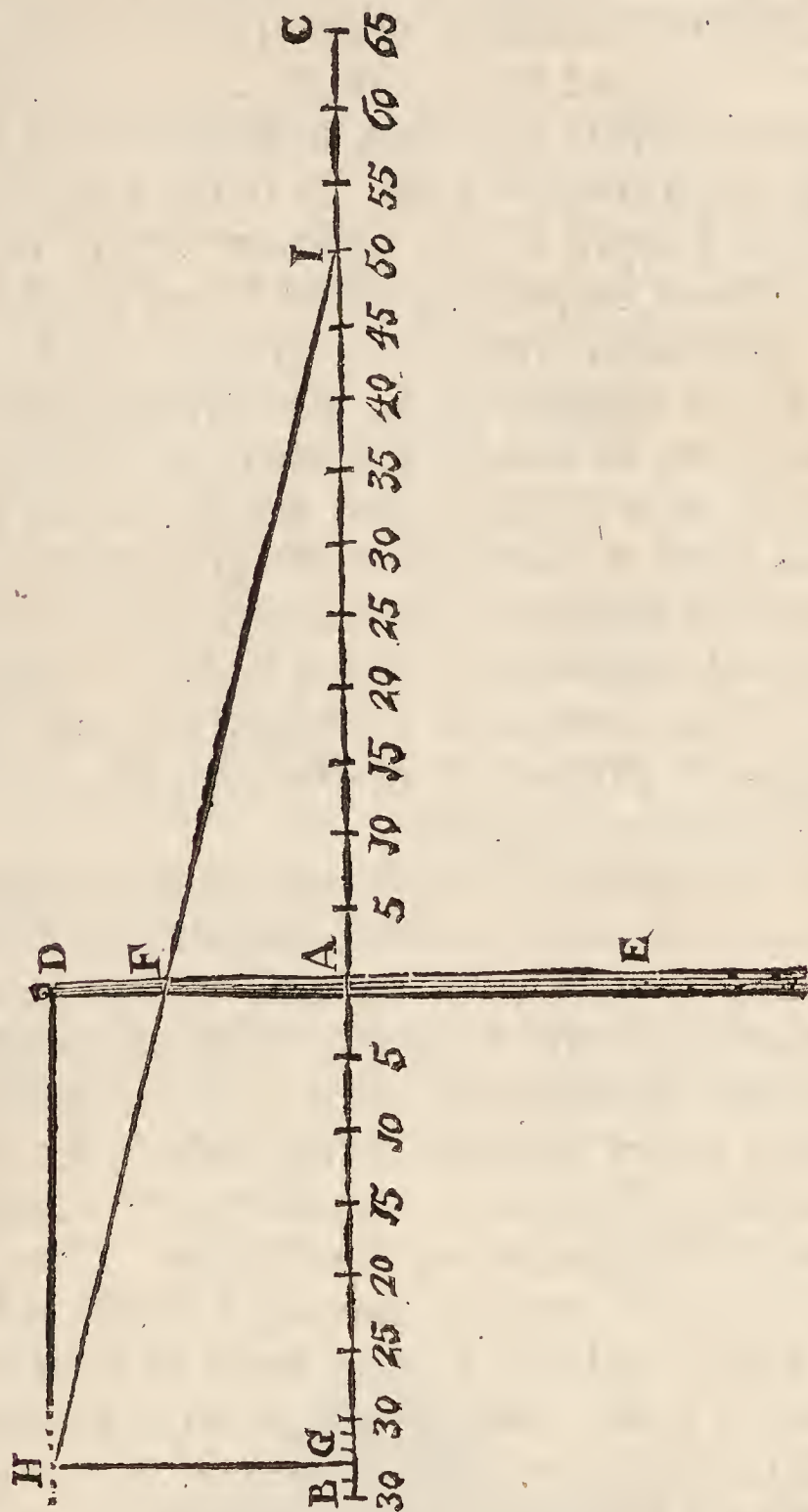
THE Arithmetical Rule was this; that the Length of the Cylinder of the Air in the Pipe, before it was press'd upon by the Water in the Pipe, should be compared to the Length of the Cylinder
of

of the same Air, when compress'd by the Water of the Pipe, and the Difference noted; namely, the Length of the Cylinder of Water thrust into the Pipe, by the Pressure. Then to resolve this Proportion. As the Length of the Cylinder of Water thus compress'd, is to the Length of the Cylinder of Water so thrust in; so the Height of the Standard of Water, at the Time of Trial, to the Height of the Cylinder of Water pressing in the Pipe, which is equal to the Height to which the Water of that Pipe, so press'd, will ascend above the Surface of the Water in the small Pipe.

THE Height of the Standard of Water, at the Time of Trial, is easily known by the Height of the Mercurial Standard at that Time; which, being now grown very common and useful, is almost every where to be met with, and may otherwise be easily supply'd; for as the Weight of Water, to the Weight of Quicksilver, so the Mercurial Standard, to the Height of the Water Standard.

THE Weight of Water, to that of *Mercury*, is by many Trials found to be near as 1000 to 13593, or as 1 to 15, according to his Account following Numb. - - -

THE Geometrical, or Mechanical Way, was this. Upon a Table, or Plane



draw a Line, as B A C ; then cross it at Right Angles, with another Right Line, as D A E, then divide A B, into thirty-six Parts, and continue the same Division, from A towards C, so far as you have Occasion of Foot Heights of Pressure ; as suppose to 100 ; then

then subdivide one of these Parts, lying next to A into twelve equal Parts. Then knowing the present Water Standard, count, from A towards B, so many Parts and Duodecimals, as it is then Feet and Inches: Cross the Line, at that Point at Right Angles, with another Line, as G H, and from G, set off the Length of the Cylinder of Air in your Glass, before Compression; then set off the Length of the additional Cylinder of Water, from A towards D, as suppose to E, and laying a Rule over the Points H and F, see where it crosseth the Line A C, as at I, then count the Parts and Duodecimals from A, and that shall give the Pressure or additional Height of the Water, above the Level of the Water in your Water Poiser in Feet and Inches: The Reason of all which depends upon the reciprocal Proportion of the Strengths of Air to the Extensions thereof.

THE second Experiment, was made, to shew a Way, how to find the true and comparative Expansion of any Metal, when melted, and so to compare it both with the Expansion of the same Metal, when solid, and likewise with the Expansion of any other, either fluid or solid Body. An accurate Account of which is necessary, to compleat a History of Expansion or Gravitation. The Method of trying it was, by having a Vessel full of melted Lead, and also a solid Body of Iron to be sunk into it; this solid Piece of Iron was about $1 \frac{1}{2}$ Inch Cubical, and into it, was fastened a very small Wire of Iron, big enough to thrust it under the Surface of the melted Lead, and make it sink therein, (for, of itself, it swam upon the Lead, as Wood upon Water). This Wire was fastened perpendicularly, under a Scale, and so much Weight put into the Scale as served to make it sink under the Surface of the Lead; then taking it out of the Lead, and seeing by the additional Weights, put
in

into the other Scale, to counterpoise it, first in the Air, then in Water, or any other Liquor, the comparative Weight of each of them was easily discoverable.

THE Reason of the making of which Experiment was, to hint the Necessity there is, in all Experiments fit to be made Use of for any Philosophical Theories, of reducing them to a Certainty of Quantity; without which, no certain and unquestionable Conclusion can be made. Now tho' a certain Standard of Weight, Measure, Expansion, Power, Motion, &c. be not made Use of; yet if some one determinate Measure for each of them be pitched upon, 'twill be enough to make the comparative Trials useful; though it were to be wish'd, that some universal, natural Standard of Measure for all Things were found out, those that have hitherto been thought of, having been doubted of, as to their Universality and Certainty, at all Places and in all Times.

Not knowing when the following Experiments were made, I insert them after the foregoing, by reason of some Congruity between them.

W. DERHAM.



*An Account of some Trials for the finding out
the Pressure of the Parts of Water one
upon another ; and the elastical Power of
the Air.*

FOR the making these Experiments, there was prepar'd a long Tube of Glafs, seal'd at one End, and being erected perpendicularly, with the seal'd End downwards, it was fill'd with Water, and so fastened against the Side of a Wall ; then there was taken another small Tube of Glafs, very even drawn, and small enough to be let down within the former Tube ; this Tube was 12 Inches long, and was seal'd at one End, and divided into Inches, Halfs, and Quarters ; then, to the open End of this Tube, was hung a small, long Plummet of Lead, which would easily slip down to the Bottom of the longer Tube, and draw down the small Pipe with it ; both which were gently so let down by a small Thread, as the Experiment requir'd, which afforded these Observations. The Pipe, when the lower and open End first touch'd the Water, being full with Air, not heated by the touching the Pipe with a warm Hand, or otherwise, was observ'd by Degrees, as it descended, to be in part fill'd with Water, and so much the more by how much the deeper it descended. And observing the Degrees of Condensation of Air in the Pipe produced at several Depths, we found them to be these. At *Gresham* College, the 24 half Inches of Air lost one half Inch of its Extension
at

at 2 Halfs at 3 Halfs at 4 Halfs
 at which is therefore a 5th Part of a Cy-
 linder of Water able to counter-balance the Pres-
 sure of the Air. The whole therefore may hypo-
 thetically be judg'd to be - - - - -

I DID, since that, erect a Tube some 13 Foot
 high ; and fitting all Things as in the former Ex-
 periment, I collected this Table A, whose first
 Row of Numbers shews the equal Spaces into which
 the Air was extended ; and the last
 shews the Height of the Water above
 the under Surface of the Air. Since
 that, in the same Tube standing in the
 same Place, I reiterated the Experi-
 ment, and collected this following
 Table B.

ALL which three
 Tables, being so diffe-
 rent one from another,
 may seem to overthrow
 each other, and the Cer-
 tainty of this Kind of
 Experiment in general.
 But as I cannot vindi-
 cate the Trials from
 some Errors (it being
 almost impossible to
 make these Kind of Trials so accurate, that
 there shall be no Mistake comitted) so neither
 do I believe, that these seeming Contrarieties do
 wholly proceed from the Unaccurateness in the
 Procefs. For since the Air is sometimes under a
 greater, and sometimes a less Pressure, the Degrees
 of Force, requisite to promote the Condensation
 further, must necessarily be differing.

AND hence by the first Table, I judge the
 Height of a Cylinder of Water, able to balance
 the Pressure of the Air, when that Experiment was
 H made,

| A | |
|----|-------------------|
| 48 | 00 |
| 47 | 08 $\frac{1}{2}$ |
| 46 | 17 |
| 45 | 27 |
| 44 | 36 $\frac{1}{2}$ |
| 43 | 45 $\frac{1}{2}$ |
| 42 | 58 $\frac{1}{2}$ |
| 41 | 68 $\frac{3}{4}$ |
| 40 | 80 |
| 39 | 91 $\frac{1}{2}$ |
| 38 | 105 $\frac{1}{4}$ |
| 37 | 117 |
| 36 | 130 $\frac{1}{2}$ |

| B | |
|------------------|-------------------|
| 24 | 00 |
| 23 | 13 |
| 22 | 31 |
| 21 | 52 |
| 20 | 76 |
| 19 | 101 $\frac{1}{2}$ |
| 18 | 127 $\frac{1}{2}$ |
| 17 $\frac{1}{2}$ | 142 |

made to be by the Second Experiment I judge the counter-balancing Pillar, then to be between 390 and 400 Inches, or near about 33 Foot ; by the third, I guess it to be about 382 Inches, or near about 32 Foot. This Experiment therefore, if accurately made, at several Seasons and Times of the Year, may afford us a very easy Way of knowing the Pressure of the Air at that Time, and this more accurately and nicely, than can be perform'd with *Mercury* the ordinary Way. For whereas the Shortening and Increase of the Mercurial Cylinder, is at most not above 2 or 3 Inches, in this Experiment, the aqueous Cylinder will change fourteen times as much.

N E X T, this Experiment may help us to guess at the Pressure of the Sea Water against the Air, let down to the Bottom of it in a diving Engine, by knowing the Proportion between the Gravity of salt and fresh Water. But it were very desirable that such, as have the Opportunity of making Trials at Sea, would be diligent in it. For though there seems to be no Doubt, but that Water proportionably presseth according to its perpendicular Height ; yet it is not easy to predict, how much it may vary from that Hypothesis ; which Deviation may be caused, either from the extreme Cold at the Bottom of the Sea, which may weaken the Spring of the Air, or from the differing Gravity of the upper and lower Parts of salt Water ; or from somewhat else, whereof we may be yet ignorant. Now for the more accurate making of these Trials, I think it were very requisite to have some such Engine as this.

T A K E a good strong Glass Bottle, that will hold about a Gallon ; and let there be fitted to it a handsome Screw Cover of Brass, and shap'd like those Covers that are usually put upon Chirurgeons Bottles, that are made of Pewter. Let the Cover
be

be very well cemented on, and the Screw be made to go very close through the Top of this Cover ; let there be made several very small Holes with a Needle Drill, then hang a good Weight under the Bottle, and let it down with this Cover upmost, for by this Means, by drawing it up from several Depths, and weighing the Quantities of Water it brings up, it will be easy to know the Weight of the incumbent Column of Water.

THERE might be many other Ways, but this I take to be the most cheap, easy, and certain of any ; nor is there any Danger of breaking the Bottle, either inward or outward ; for as the Bottle descends, the Water rushes in, and as it is drawn up, the Air goes out.



The following Experiments are here inserted, by reason of their Congruity with the foregoing.

WILLIAM DERHAM.



More Experiments of Pressure.

Fig. I.

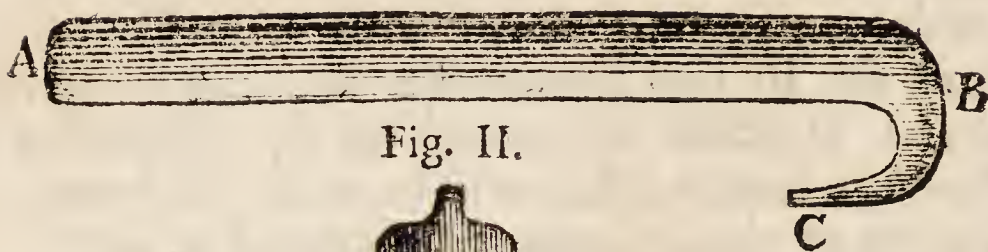


Fig. II.



THERE was taken a Glass Tube A B C, (*Fig. I.*) about 23 Inches long, and near $\frac{3}{4}$ of an Inch over ; this was close seal'd up at one End A, and the other End B was drawn into a very small Pipe C, and bended according to the Shape in the Figure. This Pipe was found to weigh $1\frac{13}{16}$ $\frac{3}{4}$ + 4 gr. or 874 Grains, being fill'd with salt Water, and the Outside wiped dry (which was constantly done in all the subsequent Trials) it weighed $4\frac{7}{16}$ $\frac{3}{4}$ + 103^r. or 2140 Grains, whence if we deduct the Weight of the Pipe 874, we have 1266 Grains for the Weight of the Water that fill'd the Pipe. This Glass Tube being fasten'd to a Line, to the End of which was hang'd a Plummet of Lead, to make it sink ; 'twas fitted so as to be let down perpendicularly into the Water with the seal'd End A foremost, by which Means the small Hole of the Pipe C was open downwards (that Hole being made purposely small, that the Air could not get out at it whilst the Water got in, nor the Water get in whilst the Air was passing out.) Then the Glass was, for a short Time, so held in the Water, that all of it, except the small bended Pipe, was cover'd and inclos'd with the Water (which was ob-

ob-

observ'd in every Trial, to the End that the Air within the Pipe, might be well cooled) and being let down to the Bottom, and there suffer'd to stay for a short Space. Afterwards being drawn up, loosened from the Line, dried, and exactly weighed; its Weight was found $3\frac{13}{16}^3 + 3$ Grains or 1833 Grains; whence, deducting the Weight of the Tube 874, we have 959 Grains for the Weight of the Water it brought up. The Place was in the Channel to the North of *Quinborough*, the Depth of the Water 16 Fathom and a Foot, or 97 Foot, where we made the subsequent Trials which are rang'd in this Table.

| | | | |
|-----------------------------------|-------------------------------|--------------------|------|
| Top full | 2140 — 874 = 1266 | | |
| At 97 Foot deep — 2 | 1833 — 874 = 959 . | 307 | |
| At 97 Ft. deep — 2 | 1832 — 874 = 958 . | 308 | |
| At 8 Ft. 3 In. — 2 Ft. | 1060 — 874 = 186 . | 1080 | |
| At 16 Ft. 6 In. — 2 Ft. | 1257 — 874 = 383 . | 883 | |
| At 33 Ft. — 2 Ft. | 1500 — 874 = 626 . | 640 | |
| At 66 Ft. | 1737 — 874 = 863 . | 403 | |
| At 66 | 1734 — 874 = 860 . | 406 | |
| At 33 | From the Mouth of the Tube | 1530 — 874 = 656 . | 610 |
| At 16 ¹ / ₂ | | 1296 — 874 = 422 . | 844 |
| At 8 ¹ / ₂ | | 1131 — 874 = 257 . | 1009 |
| At 8 ¹ / ₄ | | | |

A BUNDLE of Corks being knit up in a Handkerchief, and fasten'd to the Line at 33 Foot from the small End of the Glass, the Tube was again let down to the same Depth, and the Corks, floating upon the Water, suspended it at that Depth; for, a good while afterwards. Then drawing up the Cylinder, by measuring, the Cylinder was found to have taken in just as much Water, as it had in the last Trial, but the Weight of the Glass was not examin'd. Other Trials were made the next Day with the same Glass Cylinder, viz.

At $8\frac{1}{4}$ Foot from the Top $1172 - 874 = 298$.
Just at high Water, the Water being at a stand.

At $8\frac{1}{4}$ Foot $1131 - 874 = 257$

At $16\frac{1}{2}$ Foot $1300 - 874 = 426$

At 33 Foot $1510 - 874 = 636$

At $49\frac{1}{2}$ Foot $1635 - 874 = 761$

At 66 Foot $1712 - 874 = 838$

THE Trials did agree, by Measure, with some I had made in the Morning.

ANOTHER Trial was made of the last Experiment, because it was done when the Water had some Current, and the String seem'd to stream a good Way from the Perpendicular; to prevent which Inconvenience, the Boat was suffer'd to drive with the Current, by which Means, the Line seem'd to go down perpendicularly into the Water. So the Cane being pull'd up, after it had staid some time at the Depth of 66 Foot, it weigh'd $1719 - 874 = 845$. At $82\frac{1}{2}$ Foot, and left to drive perpendicularly $1883 - 874 = 1009$.

Wednesday, March the 11th, in the Afternoon, near the same Place, where the former Trials were made, there were made these following Experiments of Compression.

UNTIL to the Neck, or Mouth, of a common Quart Glass Bottle, was fitted a Valve, that opened inwards, and shut outwards; this Bottle was so let down into the Water, that the Mouth went foremost, by which Means, the Water had, as the Bottle was sinking, a free Passage into the

Body

Body of it, to compress the Air; but by the shutting of the Valve, when the Bottle was again drawn up, it was hinder'd from getting out. This Bottle, when empty, weigh'd $37\frac{7}{8}$ Ounces, and 24 Grains, or 18204 Grains; fill'd with salt Water, it weigh'd $78\frac{3}{4}$ Ounces and 3 Grains, or 37563 Grains; whence, taking the Weight of the Bottle 18204, we have 19359 Grains, for the Weight of the Water, that fill'd the Bottle. This Bottle being let down $13\frac{1}{2}$ Fathoms by the Ship's Plumb Line, or 81 Foot, the Valve was so hard shut, when it was taken up again, that it was difficult to be thrust open. Though when the small End, or Mouth, of the Bottle, was set upward, the Valve being made of Brass, without Leather, was found to leak a little, by the hissing Noise the Air made at it. And when by a Knock, the Valve was beaten down, the Air made a Noise in rushing out like that of a Bottle of Ale when it flies; the Bottle, and the Water it brought up, weigh'd $65\frac{1}{2}$ Ounces, or 31656 Grains; whence, deducting the Weight of the Bottle 18204, we have 13452 Grains for the Weight of the Water. This Bottle was again let down to the Depth of 14 Fathom, or 84 Foot; and, being drawn up, was found to weigh, whilst the compress'd Air remain'd in it, $65\frac{1}{8}$ Ounces, and 19 Grains, or 31279 Grains; when the Air was let out, it lost 21 Grains of its former Weight, counterpoising only 31258 Grains, which was suppos'd to proceed partly from the freeing of the compress'd Air, and partly from the Loss of a little Water, that the violent Eruption of the Air had blown away; from which last Sum, by deducting the Weight of the Bottle 18204, we have 13054 for the Weight of the Water.

March the 13th, another Experiment was made with another Bottle of the same Fashion, which empty, weigh'd $37\frac{1}{2}$ Ounces and 12 Grains, or 18162 Grains; fill'd with salt Water to the Valve, it weigh'd $77\frac{1}{2}$ Ounces and 3 Grains, or 37353 Grains; whence, deducting the Weight of the Bottle 18162, we have 19191 the Weight of the Water that fill'd it; this Bottle being let down 8 Fathom, or 48 Foot, the Bottle, compress'd Air, and Water together, weigh'd $60\frac{1}{2}$ Ounces and 12 Grains, or 29142 Grains; the Air being let out softly, which requir'd a long time, and the Bottle, and Water afterwards weigh'd, was found 24 Grains lighter, *viz.* 29118 Grains; whence, deducting the Bottle 18162, we have 10956 Grains for the Water. The Experiments are ranged together in this Table.

THE Bottle, with a bended Copper Pipe at the Top, being let down 8 $\frac{1}{2}$ Foot deep, brought up in it $4\frac{1}{2}$ Ounces, and 24 Grains of Water, the Bottle being weigh'd before-hand with a dead Weight, or counterpois'd; the same Bottle, kept longer at the same Depth, brought up $8\frac{2}{3}$ Ounces and 25 Grains of Water; the same Bottle, kept yet longer a great deal, brought up $9\frac{7}{8}$ Ounces and 6 Grains; the Water that fill'd the Bottle, weigh'd $41\frac{1}{2}$ Ounces and 24 Grains; which different Proportions of Water, taken in, we judg'd to proceed, either from the leaking of the Vessel at the Screw, by which Means, the Water had a Passage into the Bottle below the Mouth of the bended Pipe, which would therefore serve for a Vent-hole for the Air to get out at; or else that the Motion of the Top of the Water being a little uneven, the Pressure upon the Bottle must consequently alter, there being sometimes a greater, sometimes a shorter Pillar of the Water above it; secondly, the Bottle itself was, by the cockling of the Boat, some-

sometimes lifted higher, then depress'd lower, which did also alter the Height of the pressing Pillar ; whence, as the Pressure was a little increas'd, the Water got in ; and, as it decreas'd, the Air got out ; and, being held a long while in that Posture, many of those Changes did very much augment the Quantity of Water within the Glass.

Experiments of the Weight of Water.

A WHITE Glass Viol, made in the Manner describ'd in Figure II. with a small short Neck, was, by Trial, found to weigh, when empty, 1425 Grains ; when fill'd exactly full with salt Water, it weigh'd 5247 Grains ; whence, deducting the Bottle 1425, we have 3822 Grains, the Weight of the salt Water. The same fill'd with fresh Water taken out of the *Thames* at *Greenwich*, about low Water, weigh'd 5164 ; whence, deducting 1425, we have 3739, the Weight of that fresh Water. And weighing afterwards the Water, wherewith the Strong Ale at *Margat* is brew'd, we found it exactly the same with the Water taken up at *Greenwich* ; whence we conclude, the Proportion of these fresh Waters, to this salt, to be as 3739 to 3822 ; that is, near as 45 to 46.

Trials of the Heat and Cold of the Water.

A SEAL'D Thermometer was let down to the Bottom of the Water, at 16 Fathom and a Foot, with the great Ball upwards, and the Stem downward, to the End that, if the Cold were extreme, it might have so far condensed the Spirit of Wine, as to have admitted the Air to have got in out of the Neck. And so by pulling it to the Top, we might have known the Cold at Bottom ; but though the Thermometer was suffer'd to remain

a long Time at that Depth, and were suddenly pull'd up, we could not find that it had any whit more condens'd the Spirit of Wine, than it was by keeping the same Thermometer a pretty while just under the Water, at the Top, when we judg'd the Temperature of this Water, both at the Top, in the Middle, (for, by other Trials, we found the same at other Depths) and at the Bottom, to be all the same.

N. B. *The Instrument describ'd in the Nuntius ad Abyssum, much better for the Purpose than this.*

R. W.

Observations of Sound.

BEING at a Place of the *Thames*, about four Miles above *Gravesend*, there happen'd to be shot off several small Pieces of Ordnance, by a Ship that was about half a Mile farther up the River; the Multitudes of the Echoes of each of which Shots, made a Noise among the several Hills, Woods, and Banks, on both Sides of us, just like Thunder. And could they have been number'd, they would, questionless, have exceeded an Hundred. And having since had the Opportunity to observe the Noise of Thunder, it seem'd to me to be deducible partly from Echoes; which would yet seem more probable, if we could, by any Experiment, find that the Clouds would rebound or echo a Sound. A Gun being afterwards shot off by the Vessel we were in, when we were near the Mouth of the *Thames*, and several Ships being on this and that Side of us, we could very sensibly hear several Echoes rebounded from them.

Dr. H O O K's Contrivance of a very commodious Windmill ; communicated to the Royal Society, July, 11, 1683.

JULY the 11th, I read the preceding Discourse and Accounts of the two Experiments shew'd on *July* the 4th; and further explain'd each of them by verbal Discourses. Then I shew'd these two Experiments following, which I explain'd by Discourses, somewhat in the following Manner.

THE First, was the Module of a Windmill, in which were those Particulars following considerable, not to be found in any other yet made use of.

1. **T**HAT it had no Need of any House, but what might be placed, either immediately upon the Ground, or under the Ground, according to the several Uses to which it might be apply'd. Whence follow'd,

2. **T**HAT the House need not be any Impediment to the Force of the Wind, which it usually is in all other Windmills.

3. **T**HAT it doth of itself turn to all Winds, and so needs not the Attendance, Watching, and Labour of Men to set it, which is necessary in other Mills.

4. **T**HAT the Vanes are contriv'd of the most perfect Form, to receive the whole Power of the Wind, for the Cylinder thereof it is expos'd to: Which is effected by the particular Slope of the Vanes thereof, whereby the Force of the Wind becomes equal upon every Part of the Vane, from the Center to the Tip, or Extremity thereof. An equal Progression of Wind causing every Point of the whole Vane to make an equal Arch of Rotation, or an equal Angle at the Axis.

5. **F**OR

5. F O R that it needeth not so big an Axis, nor so strong Vanes as other Mills, the greatest Strength of this being in the Way of pulling, the other in the Way of thrusting; and this being capable of being strengthen'd by Ropes, like the Tackling of a Ship.

6. F O R the easy Way of producing a circular Motion below, without the Help of Trundles or Cog-wheels, which are both a great Impediment to its Motion, and do wear, and often need Repair.

7. F O R the easy Way of communicating a reciprocating perpendicular Motion, which is usually perform'd by the Help of Wheels.

8. F O R the Cheapness of it, there being so many Particulars not necessary to this, omitted, which are usually done in other Kinds, and not without Necessity.

A L L which Particulars consider'd, it makes it to be the most plain, simple, cheap, and easy to be made and used, that has been yet made; and yet the most powerful in its Effects, and the most universally applicable to all Purposes; (as grinding, bruising, beating, sawing, pumping, placing, twisting, drawing, turning, lifting, &c.) that can be made of equal Bigness.

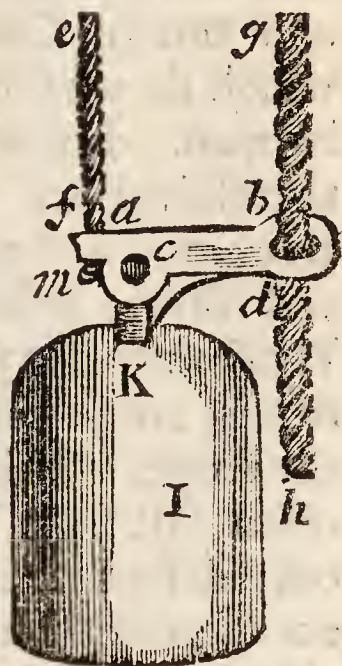
I have thought worth while, to insert this Account of the Windmill (although scarcely intelligible without Figures, or a Module, which I never could meet with) because somebody, or other, may be so fortunate to find the Module, or, by the Hints here given, contrive a Windmill like this.

W. D E R H A M.

Dr.

Dr. HOOK's Contrivance to stop great Weights falling, July 11, 1683.

THE second Experiment was a very plain and easy Way, how to stay a Weight from falling, when the Rope, or Chain, by which it is drawn up or let down, shall chance to break. This was effected by a small Arm extended out from the Top of the Weight to the Side, with a Hand, or Pipe, at the End thereof, which grasped, or inclosed, another Rope or Chain, extended from the Top to the Bottom; which Hand, or Pipe, was so wide, as to slip freely upon the said Rope, so long as the Weight was suspended by its own Rope; but so soon as that any way fail'd, the Hand grasped the Side Rope fast, and hinder'd the Weight from descending to the Bottom. This was one of the plainest, easiest, and most simple Ways of effecting this End, though the same may be effected divers other Ways, as certainly, which I have also contriv'd. The explicating it, by a Scheme, makes it the more intelligible. I represents the Weight, *a b* the Arm, moving with a Joint at *c*, upon the other Part of it *k*, fast into the Weight, *e f* represents the Rope, by which the Weight is either drawn up or let down, fasten'd to the Elbow *m*; by which Means the Wrist, and Hand of the Arm, is kept at Right Angles with the Part fast in the Weight, and so the Hand slips freely upon the greater Rope *g b*, extended from the Top to the Bottom, to which the Weight can descend; *d* represents a Spring, by which,



which, so soon as the Rope of the Weight, which holds by the Elbow *c*, fails, the Arm is extended straight; by which the Hand *b*, presently holds fast the Rope, or Chain *G b*, by being made oblique to the Perpendicular, and, so creeking the Rope, and so hinders it from falling; as, by the Experiment shewn, plainly appear'd.

THE Use of which Contrivance, though possibly it might, to some, seem very trivial and insignificant, as seeming to be calculated for keeping a Clock, or Chime Weight, from falling, is not altogether so slight and foolish; for even for that Use it may sometime or other possibly save 100 Pound Expence, and the Lives of some Men. But if apply'd, in general, for the hindering Weights to fall, it may deserve a somewhat better Value, and be found very considerable, since it may be very instrumental to save many Mens Lives, and much Charge, and great Inconveniencies, which do very often now, for the Want thereof, happen. For whereas, in many Mines, the Men themselves are often drawn up and let down in Buckets; and generally the Ores, Stones, Waters, and divers other Things, belonging to those Works necessary for procuring Ores, or other Minerals, are so conveyed; and upon the failing of the Rope, Chain, or other Part of the Engine, do often fall from Top to Bottom, and so are not only dashed in Pieces themselves, but destroy, and do oftentimes irreparable Injury to Men, or what else they meet with in their Fall. By this Means, all such Bodies are secured from the Fall, and kept hanging at the Place where they were when the Rope brake, or other Part of the Engine fail'd, and thereby the Bodies themselves are preserv'd intire, and no other Harm done by their Fall. The same Thing is applicable also to Men, ascending, or descending, by Ropes or Rope-Ladders, and to Stones, Timber, or Materials for a high Building.

Dr. HOOK's Way to take the Impressions of Medals, &c. imparted to the Royal Society. Octob, 31, 1683.

HAVING been shewn, by Mr. Frazier, the Impressions of several of the King of *France's* Medals, in a certain thin transparent Substance, much like *Muscovy* Glass, but much more tough; on which, on the one Side, appear'd the perfect Impression of the Medal, in *Entaglio*, or sunk in; and, on the opposite Side, the very Figure of the said Medal in *Basso Relievo*, or swelling out. And, considering what Way this might be done, having formerly taken off the Figure of certain Carvings, by Glue, so as to be able to cast them in Plaister of *Paris*, or burnt Alabaster; upon making Trial with a Glue made of *Icthuocolla*, dissolv'd over a gentle Heat, in course Spirit of Wine, by laying it upon a fair stamp'd Crown Piece, and suffering it to lie a considerable Time, till it was thorough dry, cold, and hard; I found that it afforded me the same Kind of Substance, both for Toughness, Transparency, and Fitness, to receive and retain the Impression of the Coin upon which it was laid, as the Substance shew'd me, containing the Impression of the *French* Medal. This I shew'd the Society, and explain'd to them the Way of doing it. And also related, that the same Impressions might be so taken with common Joyners Glue; but the Plate would not be so tough, nor so transparent.

THE President mention'd, that there had been a certain *Frenchman* here in *England*, some time since, who had certain transparent Plates like *Muscovy* Glass; with which, he could easily copy out any Picture or Print, by laying it upon the
1
same,

same, and writing upon it with Ink, as on Paper; the same being very transparent; and so causing the Print, on which it was laid to appear very plain through it: And inquiring, whether I could do the same, upon my affirming that I could, he desir'd that I would shew the Experiment of it at the next Meeting.

N. B. Dr. Lister mention'd the Way of contracting Seals with Mouth-Glue.

Dr. HOOK imparted to the Royal Society this Preparation, to copy any Picture, &c.
 Novemb. 7, 1683.

I PRODUCED a Plate, made according to the preceding Desire; which had the same Properties with that which was made by the *French Gentleman*. This was very thin, and as transparent as *Muscovy Glass*, or *Selenitis*. It was also tough, and would bear Ink as well as any Paper, and so was fit to make use of, for any Experiments for drawing, or copying Pictures or Maps. The Manner of making it, I explain'd to the Society, to be thus. First, I prepar'd a very thick Cise of *Ichthuoceolla*, well dissolv'd in Spirit of Wine, and then clear'd from all its Rags and Foulness, by straining it through a clean Cloth; then taking a Looking-Glass Plate, well smooth'd and polish'd, I rubbed the same all over with a fine Rag, moistened a little with pure Sallad Oil; but so as only to hinder the Substance that was to be pour'd on it from sticking to it, but not to make it foul or uneven. Having so prepar'd these Things, I heated the Sise, and, when again pretty cold, I pour'd it upon the oiled Side of the Glass Plate,

and

and so taking the Plate, and inclining it this Way or that Way, till the whole Plate was cover'd by the Sife, I laid the Plate horizontal, and suffer'd it to lie so till it was thoroughly dry.

Dr. HOOK's several Discourses of Improvements of Scales, Beams, and other Instruments, for weighing Bodies more nicely; and first, one to find any desired Part of a Weight, or Body to be weigh'd. Dec. 5, 1683.

I PRODUCED an Instrument for the speedy and exact finding any desir'd Part of any Weight given, whether Commensurate, or Incommensurate. The Instrument, (being only a Module, and to serve only for Explication and Experiment, and not for constant and continual Use) was a slender Fishing-Cane, streightened very well, of about four Foot in Length, and tapering from one End to the other; this Material I made use of upon a double Account; *First*, for its Stiffness; and, *Secondly*, for its Lightness, that I might, as near as possible, make it to be without Weight, and bending, and so approach to, or represent, a *mathematical Line*. Now the Part, I propos'd to find, being a *Decimal*, *Centesimal*, *Millesimal*, or the Powers of the *Decimal Fractions*, I divided the Cane into eleven equal Parts; at one of which, from the greater End, I, with a Needle, drew through it a small Silk Thread, by which I suspended it; and by adding Lead to the shorter End, I pois'd it, until it came to an *Equilibrium*, and so it hung *horizontally*. Then I made two *Scales*, with two Rings, whose inner Edges were thin and sharp, by which they might hang upon the Ends of the *horizontal, or equilibrated Cane*. The Scale and
I Ring,

Ring, for the greater and shorter End, was made ten times as heavy as the other Scale and Ring for the smaller and longer End. These being thus prepar'd, I hung on the Scale upon the greater or shorter End, at any Distance from the Thread : Then, hanging on the little Scale, upon the lesser End, moving it nearer and farther from the suspending String, till the Beam hung *in Equilibrio*; the which became an Instrument for finding the Decimal, Centesimal, or Millesimal Parts, or Fractions of any Weight given. Suppose a Pound be to be so divided ; Put the Pound into the great Scale, and then counterpoise it with Weight, as of Sand, Water, Minium, &c. in the lesser Scale ; this shall be a tenth Part of a Pound : Remove the Pound, and put the Decimal Counterpoise in the greater Scale, then counterpoise this in the lesser, and this shall give a Centesme of a Pound : Remove the Decimal, and put the Centesme in the Greater, and the Counterpoise to it in the Less, shall give the millesimal Part of a Pound, and so onward for the ten thousandth, hundred thousandth, or thousand thousandth Part of a Pound ; which, this Way, may be most exactly found and determin'd : And the like for any other assignable Part whatsoever of commensurate, or incommensurate Proportion, to the whole Quantity, of what Weight soever ; the Beams being accordingly proportion'd in Strength and Dimensions, whether it be for great and massy Bodies, or exceeding minute and curious ; and, by this Means, with some small Addition, the smallest Bodies may be as certainly weigh'd, as the most tractable, even to the thousand thousandth Part of a Grain, far beyond the Reach of the Hand, or the naked Eye. And, as the *Microscope* doth help the Eye to make *invisible Bodies*, and *Parts visible*, so may this help the Hand to make the *intractable Bodies tractable* and *ponderable*

*rable, and comparable, by other Trutinations than those of Sight; which is of considerable Advantage in the Inquiry after the several Natures of the Intims of Things, as I may hereafter shew, more particularly. In the mean time, I conceive, there was no great Reason for any, either to affirm the Experiment false or erroneous, or to slight it for its Plainness and Obviousness; since any, that understands mechanick Principles, will save me the Labour of making a Demonstration. And how obvious soever it be now known, yet I do not find it hath been taken Notice of by any Writer of *Mechanicks*; nor did I ever know any that had used it, or taken Notice of it, for this Purpose; and though it may be said to be a *Stilyard*, yet 'tis as differing from the common Use of the *Stilyard*, as that is from a *common Beam*. I mention'd also, how necessary an *Instrument* this was in almost all *Philosophical Examinations*, especially in all Trials that concern the Limits and Bounds of Powers, in the *Intims of Bodies*. This *Proportional Balance*, will be of general Use, and to such, particularly where Weights are troublesome to carry and remove; and, I suppose, the only Reason, why it has not been used, is, because it has not been thought of; though it were altogether as obvious, as to set an Egg on End.*

This Instrument being easily understood without a Figure, I have therefore omitted the giving any.



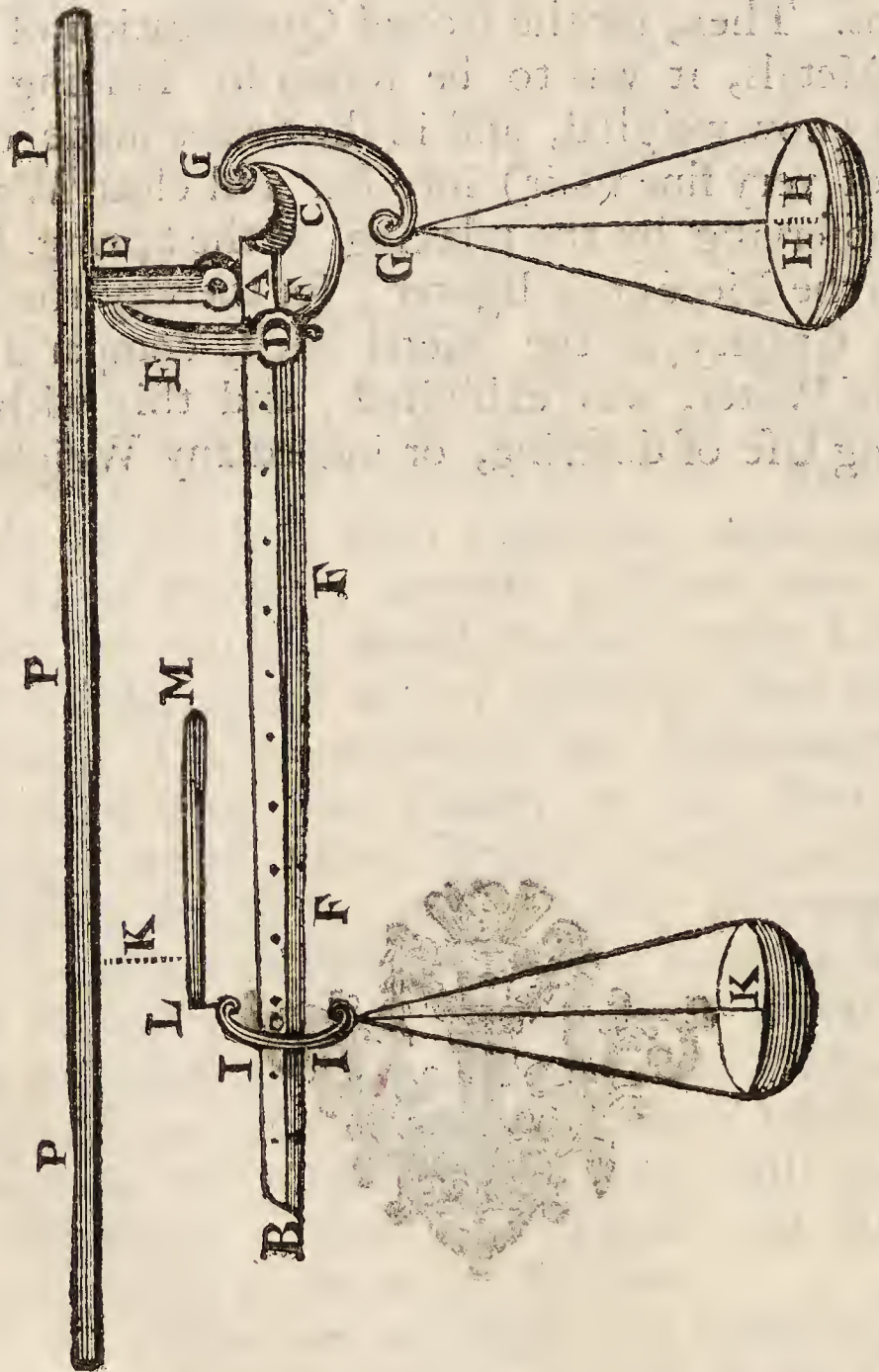
*A Second Instrument for weighing; or, a
Sort of Essay-Scale.*

D*Ecember* 12, 1683, I produced another Experiment, which was also an Instrument for weighing, which might also be of very general Use; and that was not only for examining the Weight of any Sort of Gold or Silver Coin, or any other Vessels or Pieces of those Metals: But also for examining and assaying the Nature of the Metal itself, of which those Pieces, or Vessels, should be made, both as to the Species of the Metal, and also as to Fineness, Purity, or the contrary Qualifications of them. Now though this be to be done by means of ordinary Gold Scales and Weights; yet, I dare affirm this Way to be altogether as sure as the other, and abundantly more easy, both for Carriage and Use. And there might as well have been Objections made against the Art of Printing, because a Writer was able, before that Art was found, to have wrote Letters, and Words, as fair as they could, by that Art, be printed. The Invention of the Instrument was grounded upon the Theory of the Nature of Springs, which I have formerly shew'd, and explain'd in this Place; and the Way of examining the Goodness or Badness, of this Kind of Metal, and of discovering the Species of the Metal itself, was grounded upon the Experiment of *Archimedes*, improv'd and explain'd by *Getaldus*; which two Theories, being rightly understood, will take off all Objections against the Truth and Reality thereof, with all impartial Persons.

THE Instrument was made of a Coyle of Brass Wire, one End of which, was held in the Hand, and, to the other End, was fasten'd a small Net of Hair, in which Net, the Piece of Metal to be

examined was put ; and then the whole was lifted up by the Hand, and, by means of a small Top of a Feather, fasten'd to the lower Part of the Wire, the Length of the whole Spring augmented by the Weight of the Piece try'd, was observ'd, and by the Division on the said Feather, the Number of Grains were to be taken Notice of ; this gave the Quantity or Weight of the Piece itself in Grains. Then, for the second Qualification of the said Metals, it was to be found by holding the Piece (now weigh'd, and in the Scales made of a Net of very fine Hair) into fair and clear Water, and observing by the relaxing of the Spring, how much the Piece grew lighter ; for thereby the specifick Gravity of the Metal itself, compar'd to that of Water, was exhibited ; and this without making Use of differing, or indeed any Weight at all.



*A Third Instrument for the same Purpose.*JAN. 9, 168³Scales copied from the *Royal Society*, Regist.
Numb. VI. p. 136.

I S H E W ' D a Module of a *Beam*, whereby readily to find any aliquot, or aliquant Part of any Weight given. The Beam was made in the same Manner

Manner as the first that was shewn ; namely, that with a Cane ; but whereas that was only then divided and design'd for Decimation, or Decuplation, the longer End of this was divided into 12 equal Parts, and the Face of the Beam was made so wide, as to be capable of admitting Subdivision by Diagonals. The shorter End was one twelfth Part of the longer ; at which Distance, the great Scale was properly fixed, wherein the Weight, to be subdivided, was to be put : This Scale, when empty, counterpoised the longer End, without any Scale suspended on it : And that the removing of a Scale might make no Alteration of the former *Equilibrium*, the Weight of the same was wholly taken off by a proper Counterpoise, so that the Scale had no Weight at all upon the Beam. The Way of finding any desirable Part of a Weight given, was thus ; If the Part were not smaller than a twelfth Part, then the same might be easily found by one Operation, by placing the Scale at such a Distance from the Axis of the Beam, on the longer End, that the same shall be in such Proportion to the shorter End, as the whole Weight is to the Part design'd ; for Instance, having a Lump of *Ambergrease*, of an unknown Weight, but 'tis to be divided into three Shares, which are to be in Proportion, one to another, as 345, 234, and 123, to find each of these, I thus proceed ; adding all the Proportions together, I find they make 702 ; then, by a Sector, by the Line of Lines, I open the Compasses to the Length of the shorter Shank of the Beam ; and, by that, open the Sector to 345 ; then, on the same Sector so opened, I open the Compasses to 702, and set off that Distance on the longer Shank of the Beam, and there place the lesser Scale ; then putting in the Lump into the greater Scale, I counterpoise it in the less, and that gives

me the first Share, which is as 345 to 234, and 123 ; this Weight I lay by.

Then upon the same opening of the Sector, I take off 234, and setting it on the longer Shank, I place the lesser Scale, and proceed as before ; and this gives me the Weight of the second Part, namely, 234. Then the Difference between the Sum of these two, and the whole, in a common Balance, gives me the third, *viz.* 123.

IF the Part, to be found, be less than a twelfth Part, and not less than a one hundred forty fourth Part, by some previous Division of it, by once weighing, I reduce it to such a Part, as, by the second weighing, I find the Part, to be found, will not be less than a twelfth ; and then I proceed as before. This may be perform'd, either by finding two Dividers of the Part, both which shall fall within the Compass of 12 ; or, if it be a prime Number, then by extracting the Root of it ; which may be done arithmetically in Decimals, to what Accurateness shall be desir'd, or by a Line of Superficies on a Sector, or by a Table of Logarithms.

IF the Part to be found, be less than a one hundred forty fourth Part, and not less than a seventeen hundred twenty eighth Part, then it must be perform'd by three Dividers, if such can be found, that will fall to be each not less than a 12th, or else, by the Extraction of the Cubick Root. If the Part be less than a 1728th, and not less than a 20736th Part ; then, by finding four Dividers, each, within the Compass of a twelfth, or by extracting the quadrato, quadratick Root, the Part may be obtain'd by four Operations.

The fourth Instrument for weighing.

JAN. 16, 1681.

I S H E W'D a new Instrument I had invented, by which, immediately, and without any Trouble, the comparative Weights of any two Bodies given, might be found; if, at least, the Beam were of Bigness enough to bear them. The Beam was made in the Form of a Cross, equilibrated upon a sharp Edge in the Center; the Scales were hung upon two Ends (not opposite, but) next together, which were also equilibrated; the smallest Weight, in either of the Scales, would make the Arm, by which it hung, to stand perpendicular, and, consequently, the Arm that bore the other Scale, to lie horizontal. The Bodies to be weigh'd, were each of them put into the Scales, one in the one, and the other in the other; and so suffer'd to take their Posture (which they would presently do) by putting the Beam in such a Posture, that the Distances of their Points of bearing, from the Perpendicular under the Center, would be in reciprocal Proportion to their Weight. Dividing then the Arm, on which the greater Weight hung, into ten equal Parts, and each of those into ten, and, if the Beam will bear it, each of those again into ten, all of which, will make one thousand equal Parts, I place three Pins upon each of the other Arms, which cross the aforesaid Arm at Right Angles; the first two, at the Extremities, the next two, at the Distance of one tenth from the Center, and the third Pair, at the Distance of one hundredth; then I provide two Bullets, equiponderant to each other when fitted, the one with a small Clew, somewhat more than the Length of the longest Diagonal of the two suspend-

ing

on I, the Scales hanging at A and B. The Weights being put, the heavier in B, the lighter in A, the Cross positeth itself as in the Scheme in respect of the horizontal Line EF, and the Perpendicular GH; and their comparative Weight is found by their several Distances from the Perpendicular IH, that is, as BN to AM, so the Weight at A, to the Weight at B. Thus far is clear from the Principle of Staticks. Let KP represent the Plumb Line, suspended at K; I say then, that IK, is to IL, as BN is to AM, or, as the lesser to the bigger Weight; for AM, is equal to IN, and the Angle NIL, is equal to ILK, therefore KIL, is similar to BNI, therefore as KI to IL, so BN to NI = to AM, so the Weight at A to the Weight at B. Q. E. D.

*The Description of a Pair of Japan Scales,
and a Japan Stilyard.*

JAN. 23, 1684.

J PRODUCED, and shew'd three several Kinds of Beams, for weighing the Gravity of Bodies; the first, was a Pair of *Japan* Scales and Weights, made and adjusted in that Country, and that with very great Care and Curiosity. The Beam was made of a round Rod of Brass, tapering a little from the Middle towards the Ends; which were flatted perpendicularly, and had each of them a small Hole drill'd through it, tapering both Ways to the Middle, leaving an Edge round the Middle of the Hole, through each of these Holes, was put a Brass Ring of Wire, by which the Dishes were suspended by four Strings. The Cock, or Tongue of the Beam, was neatly foder'd into

into the Middle of the Beam, about two Inches broad below, and $\frac{1}{4}$ of an Inch at the Top; and about the Middle, between the Beam and the Top, was put the Pin, upon which the Beam play'd; the Handle of the Beam was also made of a Kind of Ring of Brass, and the lower Part thereof, was slit so as to receive the Cock, that it might just freely move between its Sides and no more; and the Pin rested upon two Holes made in the Sides of the said Handle; the Top of this Handle had a small Tongue of Brass, of the same Breadth with the Top of the Cock of the Beam, and pointing so directly at it, when in *Equilibrio*, and so near approaching it, as just not to touch it. This Beam was suspended by a convenient Frame of Wood, as to hold it steady whilst it was made use of; and to find exactly the *Equilibrium*, by giving a little Knock with a small wooden Mall, upon the Handle, there was caused such a shaking, as made every Thing settle into its due Place; and, by the Ends of the two opposing Cocks, or Tongues, the Agreement, or Difference, was discoverable. The Weights were all curiously, and very exactly, made of Brass; which, that they might not be adulterated, were, all over the Surface of it, stamped with the Emperor's Seal, and the Quality of each engraven upon it in the *Chinese*, or *Japanese* Characters. These are, by a severe Penalty, prohibited to be exported into any other Place, and are of great Value in the Country itself. The Weights are *Cunderines*, *Maces*, and *Tales*; ten *Cunderines*, making a *Mace*; ten *Mace*, a *Tale*; and 10 *Tale*, one Pound *Troy*.

THE Second, was a *Japan* Stilyard, made upon the same Principle as our common Stilyards, but with greater Curiosity, and for smaller Weights, than we generally use them, serving to weigh any Weight from a *Cunderine*, to two Pound *Troy*, or
twenty

twenty *Tale*. The Beam was made of a tapering Rod of Ivory ; the Scale, or Dish, at the greater End, was hung by a strong Thread of Silk, which pass'd through a Hole in the bigger End of it ; instead of Handles also, there were three strong Threads of Silk, at several Distances from the former, which pass'd through three several Holes in the Beam ; and to each of those three handling Threads, was adjusted a Line of Divisions upon the Sides of the tapering longer Arm ; the Weight was of Brass, and suspended on the longer Arm, by a small Bow of Silk, which might be easily slipped to and fro, as Occasion required. The whole Instrument was very compleat, and nice enough for the Purposes it was design'd for, to wit, for weighing Silver and Gold, &c. in the Way of Trade.

THE third, was a Stilyard of my own Invention, by which the Weight of any Body, that could be weigh'd in it, might be found without the Trouble of removing the Weight, as in the common Stilyard ; and, by Means of a Plumb Line, after the Manner of the Balance I shew'd *January* the 16th, the particular Weight of whatever was put in the Scale, was presently manifested ; and it had this great Conveniency in it, that the Divisions, by which the Weights were determin'd, were altogether as great at last, as at first, being all equal. The Conveniencies and Uses, are obvious enough in the weighing, either of great or small Bodies, all being to be perform'd with great Speed, and as great Exactness, and with much less Trouble.

[*In the Minutes of the Royal Society, of Octob. 25, 1677, I find an Experiment made that Day, by Dr. HOOK, which, for Congruity, I shall insert here.*]

IT was a very easy Way to examine the comparative Weight of Liquors, and that to so great a Niceness, as very sensibly and manifestly to exhibit such Weight of two Liquors, though they differ'd from one another, but a 100000th Part of their Weight.

THIS was performed by the Help of a large Glass, of a Pear-like Form, equalling in Bulk about three Pound of Water; which, by Shot included in it, was made almost equiponderant to Water; but yet somewhat heavier, that it might just sink to the Bottom; but by the finest Hair, tied to the Stalk, could be suspended in the Water. This Hair was tied to the Scale of a Beam; and this Poise, by a Counterpoise in the other Scale, was made to swim in the Water, so as neither to touch the Bottom, nor the Top. And when so poised, it was found, that a 5th Part of a Grain added to, or taken from the Scale, would make the Glass-Pear rise to the Top, or sink to the Bottom. Whence it was evident, that the whole Glass, weighing about four Pounds (which amounts to 22040 Grains, or 220400 tenth Parts of Grains) and that one single tenth Part of a Grain would turn it. And the Glass, when suspended, being always equal to an equal Bulk of Water, if that Weight be alter'd a 220400th Part, the Poise must be alter'd, and consequently, by Help of the Scales, be made sensible.

T H I S

THIS Experiment, and the Nicety thereof being understood by the Company, it was desir'd, that Trials might be made the next Day upon several Sorts of Water, as Pump-Water, new River Water, *Thames* Water, and Rain-Water, that so they might be experimentally satisfied of the Exactness of this new Instrument: Which is new upon this Account, that it hath not been taken Notice of by any of those who have written on this Subject; as *Ghetaldus, Stivinus, Paschal, &c.* they having only taken the comparative Weight of some small Counterpoise within, and out of the same Liquor, which they have always perform'd with the same Scales, which are no Ways fit for exhibiting the Niceness and Curiosity of this Experiment.

ON *November* the first following, the Experiment was accordingly made, and it was found, that two Grains of Salt, being put into two Gallons of Water, caus'd the Counterpoise to be considerably lighter: Which was found to be so, upon repeated Trials.



Dr. H o o k's Experiment before the Royal Society Feb. 6, 1684, concerning Magnetism in Drills, &c.

I T H E N produced the *Apparatus* for the Experiment appointed me last Meeting, in order to make out my Assertion, that the magnetical Virtue in Steel might be excited, and considerably increased by a Body not generally accounted magnetical ; and therefore, that the affirming a Body to be magnetical, because it excited that Virtue would not always hold good. The Experiment I made, to examine this Opinion, was this. I took a Drill made of Steel ; and, lest it should have had any determinate Virtue in it, as to Polarity, I heated it red hot in the Fire, and so suffer'd it to cool, quenching only the very drilling Point of it in cold Water : When it was perfectly cool, I apply'd a Needle to it, and found, that which End soever I turn'd downward, it would attract the South End of the Needle, and the upper End would attract the North ; and this, as often as I repeated the turning of the Drill, and apply'd the Needle to the Ends of it. So that it plainly appear'd to have no determinate Polarity at all, as a Drill, or the like Piece of Steel, touch'd by the Loadstone. Then I caused a Piece of Brass to be put upon a Table, and holding the Drill very near with the same Inclination, and in the same Line, that a Dipping Needle left free, when well poised, would situate itself ; I caused the Drill to be mov'd with a Drill Bow, so as to drill a pretty deep Hole in the said Piece of Brass, and thereby to warm or heat the Top thereof. Then, examining it again with the Needle, as I had done before, I found that the Drill by this Boring, or Agitation,

gitation, had acquired a Polarity or directive Virtue, as well as an attractive for the Point of the Drill, which, in drilling, respected the North, whether it were held downwards or upwards, always attracted the South End of the Needle; and the contrary End in like Manner, in either Posture, attracted the North, in the same Manner as if the Point thereof had been really touched with the Needle. In the like Manner, I found by trying with a Steel Chizzel by striking of its End, when placed in the proper Position of the Dipping Needle, that much the same Effects would be produced.

HEREUPON it was objected, that Brass itself was a magnetical Body, and therefore that this was not a sufficient Eviction; whereunto I replied, that I conceiv'd any other hard Body, placed instead of the Brass, would produce much the same Effect.

I DID therefore propound to have the same tried with hard Wood, Ivory, Bone, Glass, or Stone, which have not hitherto been accounted magnetical Bodies, to see whether they would not be a Means of exciting this magnetical Virtue; for if so, then either all Bodies, that are hard, must be said to be said to be magnetical, or else it will not necessarily follow, that every Body that excites this Virtue, is therefore to be esteem'd magnetical. And this the rather, because as I have, in Part, shewn in this Place, and as I shall hereafter make out more at large, there may be produced in other Bodies, as well as Steel, Iron, or the like, a Quality much resembling that of the magnetical; wherein, notwithstanding, neither the Magnet, Steel, Iron, or the magnetical Virtue, or Power of the Earth, is any Way concerned.

Dr. Hook's Experiment, about the Strength of Ice.

NEXT, I gave an Account of an Experiment, which I had caused to be tried in the Presence of Mr. *Meredith*, and Dr. *Aglionby*, of a Piece of Ice, plain'd true Square, of about fifteen Inches in Length, four Inches broad, and $3\frac{1}{2}$ Inches thick ; this was pretty solid, having no more Blebs in it than common Ice usually hath. This Piece of Ice, so squar'd, was plac'd upon the Engine made on Purpose for examining the Strength of Bodies, as to bearing. The Places, whereon the two Ends rested, were just twelve Inches asunder, and the Bar, whereon the Weights rested, was just placed in the Middle of the Piece of Ice, between the two bearing Cheeks, so that the Line of Pressure, the Bar being round, was at six Inches Distance from each of the bearing Cheeks ; the broader Part of the Ice, was placed horizontal, and the narrower, was placed perpendicular. All Things being thus fitted, we applied the Weight to the two Leavers of the Engine, and began at fifty Pounds ; then mov'd them to 100, 150, 200, 250, and 300, suffering the Weights to press the Ice for some Time, at every of these Positions, the Ice still bearing them, without breaking, or in the least crushing, either by the bearing Cheeks, on which it rested, or under the round Iron Bar that rested on it ; then removing the Weights to 350, and suffering them to rest upon it, in a very short Time, the Ice broke short in two, just under the Iron Bar, though it did not appear at all to be crushed, at any of the three bearing Places.

T H I S Experiment was tried, in order to find, first, the Hardness of this Body, which is produced by Cold, out of the fluid Body of Water, without the Mixture of any sensible solid Body, or, is rather the primitive Body, out of which, the fluid Body of Water is made, by a very small Degree of Heat, the Difference between the greatest Degree of Heat, it will sustain without being thawed, and the least Degree it will sustain without being frozen, being so very near the same, that one's Sense will not discover it, and even a Thermometer, but very little. So that if Heat and Cold, only, be the Causes of these Mutations, it is the greatest Instance in Nature of so considerable a Change of Texture, upon so inconsiderable an Alteration of the Causes.

Secondly, In order to find the Tenacity or Strength of this Body for bearing, and thence, to give some Reason, how it comes to bear so great Weights, moved, or resting upon it, without being broken, when it covers the Top of a River or Pond, as has been now sufficiently experimented upon the *Thames*. And though the Manner of bearing, when the Ice floats upon the Water, be very differing from the Way of bearing in this Experiment, and so the Calculation holds not the same in the one and the other; yet this Way of Trial is a necessary Ingredient of such a Calculation; since, without knowing the Stiffness of Ice, as to bending or breaking, and the Hardness of Ice, as to crushing, such a Calculation cannot be perform'd. The Case also varies very much from the Manner of the Boundings, and the Bigness of the Piece of Ice, whose Strength is to be calculated. For in a Pond, where the Edges of the Ice are first frozen to the Ground, and so the Water underneath being pent in from being able to get out, the Resistance of the Water hinders the breaking

of it, even till the resting Weight begins to crush it. And 'tis much the same, where the Surface of the Ice is very large, though it no where toucheth or resteth upon a solid Body at its Brims, there being so great a Length of Water to be moved, before the Water underneath can give Way to the breaking of the Ice. We must also consider the Weight, as bearing in the Center of a round Flake, which is very differing from that of an oblong Shape. To this Calculation we must likewise take in the rising of those ambient Parts of the Ice, which at a Distance encompass the bearing Center, since the Ice can hardly descend in the Center, without at the same Time raising some circumferential Parts, which are more difficult to be broken upwards, than the Center to be broken downwards.

*An Experiment of Dr. HOOK's, concerning
the swelling of Water by Freezing.*

THE third Experiment I tried was upon Occasion of a Report of Dr. Crone, of an Experiment try'd by himself, of applying the freezing Mixture to a Glass of Water, and observing the Water to rise in the Neck of the Glass, before any Part of the Water was frozen. Whence he conceived that the Water itself did actually expand by its Application, before it came to freezing. The Reason of which Phænomena I conceived to proceed only from the shrinking of the containing Vessel, and not from the expanding of the Water, before freezing: To elucidate which I tried the Experiments I had formerly shewn, to prove the swelling of Glass by Heat, and the shrinking of it by Cold; as also divers other Phænomena which are manifestly to be ascribed to the shrink-
ing

ing and swelling of the containing Glafs Vessel, and not at all to the swelling and shrinking of the Liquor contain'd; as the dipping such a Glafs of Water, in hot Water, will presently make the Water descend in the Neck; and the dipping the same in Water colder, then the Water in the Glafs, or then the Glafs it self, will make the same Water rise for some Time in the Neck of the Vessel. However, tho' some Trials were made, whose Effects seem'd, to me, plainly to concur with this Explication, yet the Doctor, and some others, seem'd yet to doubt, whether the Water it self did not actually swell by the Application of the freezing Mixture, before it actually began to freeze; which if these Trials do not satisfy, there may be several other Ways made use of to find the swelling of the Glafs by Heat, and the shrinking of it by Cold. But I conceive no Experiment can be made that will prove Water, without freezing, to be dilated or expanded by Cold, or contracted or condensed by Heat.



*Dr. H o o k's Experiments, Feb. 13. 1683-4.
Shewing the specifick Gravity of Ice, &c.*

I Took then a Piece of Metal big enough to sink the Piece of Ice, I designed to examine, to the Bottom of the Water, that so the compound Body of Ice and Iron might have a sensible Gravity in the Water. Then letting it down into the Water, which I had set conveniently in a Glass, that I might see this Compound freely to swim to and fro clear below the Surface; the Scales being conveniently sustained by a Frame, I counterpoised it exactly to an Equilibrium, and found it to amount to $1933\frac{4}{8}$ of 3000 Parts of a Pound Troy, which were the Weights to which I reduced this, and all the other Counterpoises. Then I suddenly lifted up the Ice and Iron into the Scale, and so counterpoised it in the Air, and found the same to be $2567\frac{6}{8}$ of the same Parts; then I took off the Ice, dry'd the Scale, and let the Iron Weight hang by the same String in the Water; and counterpoising it, I found it to amount to $1984\frac{1}{8}$ of the same Parts; then lifting the Iron out of the Water, and putting it into the Scale, I found it to be counterpoised by $2209\frac{7}{8}$ of the same Parts. Thence the Weight of the Water, equal in Bulk to the Ice and Iron, was $634\frac{2}{8}$ of the like Parts, and the Weight of the Water, equal to the Ball, was $224\frac{6}{8}$; thence the Weight of the Water, equal to the Ice was $409\frac{4}{8}$, and the Weight of the Ice in the Air was $358\frac{1}{8}$, and consequently the Weight of the Ice in Water was $50\frac{7}{8}$; that is, the Weight of the Ice, to that of the Water, was very near, as 7 to 8; that is, the Ice was lighter than the Water, by an eighth Part of the Weight of the Water; or the Water heavier than the Ice, by a seventh Part of the

the Weight of the Ice. So that the Expansion of the Ice, to the Expansion of the Water, was as the Weight of the Water, to the Weight of the Ice; that is, as 8 to 7: So that the Water, by its freezing, becomes expanded one seventh Part of its Bulk, and consequently that 7th Part must float above the Surface of the Water, and $\frac{1}{8}$ of the Bulk of Ice must remain immerfed in the Water $\frac{1}{8}$ Part of the Bulk of the Ice floating above it.

THE Ice I made use of, in this Experiment, was not very full of Blebs, or Bubbles; nor was it perfectly free of them, but of a middling Nature, which may pretty well hold, as a Standard, or common Measure of a great Congeries of several Sorts of Ice, some of which may be much more porous, and some much less, as I have had Occasion several times to observe, in this great Frost. The Time, in which I try'd this, was pretty warm, and so it thawed; and the Water having stood all the Day, exposed to the Air, was consequently much of the same Temper; and thence I counterpoised the Ice and Iron first in the Water, and then presently lifted it out of the Water into the Scale, so that all that levitated in the Water was immediately put in the Scale: The Water was ordinary Pump, or Well-Water, and is accounted a pretty good fresh Water; which Circumstances I mention, as having Significancy, as will by and by appear.

FOR from this Experiment it plainly appears, that the common Opinion that the Ice, upon a sudden Thaw, sinks to the Bottom, is false, tho' never so confidently asserted by the Water-men; For in this Experiment, where the Water was pretty warm, in respect of Ice, and thawed the Ice very fast; yet an eighth Part of the Ice floated above the Water, and Water by Heat, without boiling, will not expand near that Proportion:

Nay, I have found, that throwing in a Piece of Ice into Water boiling, it still floated, and sunk not, much less can it sink in a tepid Water upon a Thaw.

NEXT, from hence we may collect, that in the Northern Seas, at least one Eighth Part of the Bulk of any Body of Ice floats above the Water: I say, at least an Eighth; for possibly it may be one Seventh; for first (as is affirmed by many Voyagers to the Northern Seas) the Ice is found to be pretty fresh, and to have little or no Taste of Brackishness; and so, one Part taken with another, not heavier than this Ice I made use of. Next, the Water, notwithstanding, in which it floats, is salt, and consequently about a 40th Part heavier than common fresh Water. Thirdly, This salt Water, tho' it do not freeze, is yet pretty near the same Degree of Coldness with the Ice that floats in it, and consequently yet more heavy than the same Water when more tepid. For as I shall hereafter prove, Bodies that freeze not, are yet not less cold than other Bodies that do freeze. Fourthly, That the Sea-Water, near the Bottom, is yet much more cold, and much more salt, than in the same Place it is near the Top, and consequently must much contribute to the floating of a greater Part of the Ice. That the Water is colder at the Bottom, than above, was positively affirmed by Mr. Roachford, who try'd it in the *Sound*; and that salt Water is saltier at the Bottom, than at the Top, any one may find.

ALL which Particulars consider'd, it will not seem altogether so incredible, or indeed strange, that there should be floating Islands of Ice in the frigid Zones, of so great a Height above the Surface of the Sea: For, supposing it to be globular, above a 4th Part of its Diameter must float above the Water, to make a 7th Part of its Bulk to float,
and

and consequently the Depth of the Ice under Water need not be so very great, to make so great a Height above the Water; but if the upper Parts of it above the Water are yet much higher, and more spongy than solid Ice, as consisting, in great Part, of Accumulations of Snow, then may that Height, above the Water be raised much higher, and be made possibly to equalize, if not exceed, even the Depth of the Ice below the Surface of the Water, especially if the Bottom of the said Island be flat, as most probably it is, and as broad, if not broader, than the Compass of it at the Surface of the Water; as also if Parts above the Water be tapering, like a Pyramid, to the Top. Again, If the lower Parts of the Sea, in those Parts, are colder than at the Top, as probably it may be in the Spring, the fresher Parts of the Water may be congealed, even at the Bottom, and so augment the Bulk of it by new Accretions underneath, and so continue to buoy it up more and more, and so raise the upper Parts more and more into the Air. And consonant to this we find, that the greatest Islands of Ice are found in the Spring, after the Winter is past, and the Air begins to have a Tepidness in it; and not so much, if at all, in the former Part of the Winter, when it freezes more violently at the Top of the Water.

As to the Reason why Water, when of such a Degree of Temperature, becomes so solid a Body; and why, when of another Temperature, it becomes so fluid, I shall not now spend your Time in explaining, designing to do it in my General Theory of natural Operations. This only I shall mention here, by the by, that the Body of Ice, tho' very hard, is very little sonorous, in respect of Glass, which to the Sight it so much resembles: That the Blebs in it are not Vacuities, but a Kind
of

of Air, which has its expansive Power, or Elasticity, as well as common Air: That this Air does not, upon the Thaw, retreat into the Water, as it seems to come out of it upon the freezing, as by Experiment I have found.

*Farther Experiments, made Feb. 20. 1683-4.
by Dr. HOOK, before the Royal Society,
concerning the Phenomena of Ice.*

THE proceeding Discourse was read, and some Matters therein more particularly explained by Description partly, and partly also by Experiments.

THE Experiments were first to shew, that the Blebs in Ice (supposed by some to be Vacuities, like the Blebs in Glafs Drops) are filled with Air, which has the same Properties with common Air. I took then a Piece of Ice, and putting it into Water, which was tepid, as having stood in a warm Room, by which the outward Parts of the Ice quickly thawed, and so there remained nothing at all of Air sticking to the Outside of it; then whelming a Cup-Glafs clear over it, which was perfectly filled with Water, and had no Air included in it, I suffered it to remain, covering the Lump of Ice, till the whole was thawed, or melted into Water; and it was plain to be seen, that as the Ice thawed, the Blebs that were visible in it, before the Thaw, did ascend to the Top of the whelmed Glafs, and then unite with one another into a considerable Body of Air.

THE second was to shew that Water, though boiling hot, would yet be ponderous enough to make the Ice to swim and float in it. This was done by putting a Piece of Ice into a Vessel of
boiling

boiling Water: And the Ice continued to float upon it till it was all melted.

THE Reason of the Experiment was in order to find out the Nature of the Expansion of freezing Water, and the true Cause thereof; which seems to contain as many difficult Phenomena in it to be explain'd, as any other in Nature: For first, this Body of Ice seems heterogeneous to all other Bodies; which being melted, and suffered to cool and grow hard, are still condensed and shrunk into a lesser and lesser Room, as they grow colder; as is very observable in all Sorts of Metals, as Gold, Silver, Copper, Tin and Lead, every of which, when they are melted, take up more Space, or are more expanded, than when they are grown cold and hardened; as one may presently find, by casting any of them into a Mould, and observing the setting, or shrinking of the Gitt, by which the Mould is fill'd; or by suffering the whole Body, so melted, to remain, and grow cold and solid in the Ladle or Crucible; for 'tis evident that the top Surface, which, when melted, is protuberant, and swelling upwards; when cold, it is flatted, and very often concave. And sometimes also, in some Metals, it is crumpled, and shrunk into curious Figures; as is very remarkable in *Regulus Martis*, made with *Antimony*, which is therefore called *Stellatry*, for that it hath some Resemblance to the Figure we generally make for a Star, viz. six Radiations from its Center. 'Tis evident also in Tin and Lead; Wax also, and some resinous Substances, shrink upon hardening after the same Manner, and Fatt, or Tallow of Animals; so all Sorts of Vitrifications and Glasses, and all Sorts of Oils, that will harden, and Butter, which also grow opaque. But Water, when it passes from Fluidity to Solidity, proceeds very differing; *First*, In its instantaneous Change.

2dly,

2dly, In its Expansion, or Rarefaction. 3dly, In its Transparency. 4thly, In its Refractiveness. 5thly, in its Generation of Blebs, or Bubbles. 6thly, In its Power of Expansion: tearing and rending to Pieces the strongest metalline Bodies that imprison it; when, as yet, it leaves Room enough for the small Particles of Air to expand, if at the same time it may not be said to suck it in; for I do not find that the imprison'd Blebs are at all press'd, nor is their Spring at all the Cause of this Expansion; for by observing the thawing of a Bleb in the Ice, I did not find the Bubble that rose from it to be any bigger in Bulk, than the Bleb that contain'd it; whereas if the Air in the Bleb should be press'd with as great a Force, as the Strength of the Inside of the containing Vessel amounts unto, it must of Necessity reduce the Air to near a thousandth Part of its natural Extension; and consequently, when the Bleb comes to be thawed, and so set at Liberty, it must at least, I say at least (by reason it then suffers a greater Degree of Heat, than when it is frozen) expand itself into a Bulk a thousand Times bigger; but there is no such Appearance that I could observe. Several Authors have endeavour'd to give Solutions of this Phænomenon, as particularly the ingenious Mr. *Des Cartes*, who supposing the Particles of Water to be very long and limber Bodies, like so many Eels, whilst, as it were, kept alive, and agitated by this *Materia Subtilis*, are limber, and so easily complicate and slide one within another, and suffer the *Materia Subtilis* to have its Passage free through them every Way; but when there is less Agitation of this *Materia Subtilis*, they do, as it were, die, and grow stiff and rigid, and so will not so easily comply to the Figures of each other, but grow solid and hard: But then 'tis to be consider'd, that the greater Plenty there is of the *Materia Subtilis*,
the

the greater must be the Agitation of them ; as he asserts in the Explication of the Particles of the Air, and consequently the more Room must they take up, and so be more expanded when fluid, then when solid. Another late Author supposes, that Congelation is made by a *Sal Armoniack*, breathed, or exhaled from Animals, which, in cold, frosty Weather, is very copious in the Air, which *Sal Armoniack* does then insinuate into the Pores of the Water, and so wedge up all the Pores, and widen them, and so make the Parts of the Water to coalesce into a hard Body. But this I conceive to be also hypothetical, and not experimentally proved ; for tho' there may be some volatile Salts in the Air, yet 'tis pretty difficult to conceive there should be so great a Quantity, as at once to wedge up all the Water of the Northern Part of the Earth, and yet, at the same Time, we should not smell it ; besides, we do not find that the *Sal Armoniack* Spirit does perform this Effect, when it is raised in the Air at other Times ; nor does the *Sal Armoniack* it self, when mixed with Water or Ice, do it ; for we find that *Sal Armoniack*, strow'd on Ice, will the sooner make it thaw, and resolve again into Water, than make it freeze harder : Others have given differing Explanations, but I have not met with any yet, that, in my Opinion, give a clear and satisfactory Solution of it. Nor shall I at present trouble you with Theories, or Speculations, which some may possibly have a Prejudice against ; only suffer me to acquaint you with a Phænomenon or two, which, if you think any of them worth seeing, you may have tried, for they are very obvious, plain, and neither difficult nor chargeable Experiments, tho' possibly as instructive as the most difficult, chargeable, or pompous Experiments, to shew some Sorts of Expansion.

T A K E then a Urinal, and fit into it a Stopple of a dry Piece of Wood; then put the End of this Stopple into a Dish of Water, and you will find, in a little Time, the Stopple will grow so much bigger, as to break the Urinal.

Secondly, T A K E another Urinal, and fill the same with Pease; then filling it up with Water, stop the same with a Cork, which you may tie down fast with a Packthread; then let it remain some Time, and you will find the Pease will swell and break the Glafs.

Thirddly, T A K E Plaister of *Paris*, or burnt Alabafter, and put it into a wooden Dish, and temper it with Water, till it be very soft and fluid, that it may be easily poured out; then with this Mixture fill a Urinal or Vial top-full, suffer it to stand upright till it sets into a solid Body, and you will find it swell and break the Glafs.

Dr. HOOK's Discourse to the Royal Society, May 21. 1684. shewing a Way how to communicate one's Mind at great Distances.

T H A T which I now propound, is what I have some Years since discoursed of; but being then laid by, the great Siege of *Vienna*, the last Year, by the *Turks*, did again revive in my Memory; and that was a Method of discoursing at a Distance, not by Sound, but by Sight. I say therefore 'tis possible to convey Intelligence from any one high and eminent Place, to any other that lies in Sight of it, tho' 30 or 40 Miles distant, in as short a Time almost, as a Man can write what he would have sent, and as suddenly to receive an Answer, as he that receives it hath a
Mind

Mind to return it, or can write it down in Paper. Nay, by the Help of three, four, or more, of such eminent Places, visible to each other, lying next it in a straight Line, 'tis possible to convey Intelligence, almost in a Moment, to twice, thrice, or more Times that Distance, with as great a Certainty, as by Writing.

FOR the Performance of this, we must be beholden to a late Invention, which we do not find any of the Antients knew; that is, the Eye must be assisted with Telescopes, of Lengths appropriated to the respective Distances, that whatever Characters are exposed at one Station, may be made plain and distinguishable at the other that respect it.

First, FOR the Stations; if they be far distant, it will be necessary that they should be high, and lie exposed to the Sky, that there be no higher Hill, or Part of the Earth beyond them, that may hinder the Distinctness of the Characters which are to appear dark, the Sky beyond them appearing white: By which Means also, the thick and vaporous Air, near the Ground, will be passed over and avoided; for it many Times happens, that the Tops of Hills are very clear and conspicuous to each other, when as the whole interjacent Vale, or Country, lies drowned in a Fog. Next, because a much greater Distance and Space of Ground becomes visible, insomuch that I have been informed by such, who have been at the Top of some very high Mountains, as particularly at the Top of the *Pike of Teneriff*, that the Island of the *Grand Canaries*, which lies above 60 Miles distant, appears so clear, as if it were hard by; and I myself have often taken Notice of the great Difference there is between the appearing Distance of Objects seen from the Tops and Bottoms of pretty

ty high Hills, the same Objects from the Top appearing nearer and clearer by half, and more than they do when viewed from lower Stations of the Hills; and this not only when the Space between them was Land, but where it was nothing but Sea. I have taken Notice also of the same Difference from the Prospect of Places from the Top of the Column at *Fish-street-Hill*, where the Eye is, in good Part, raised above the smoaky Air below.

NEXT, the Height of the Stations is advantageous, upon the Account of the Refractions or Inflections of the Air; which Inflections of the Air are many and very great, sometimes in an Air which seems, to the naked Eye, the most clear and serene. Infomuch that That alone does wholly confound the Distinctness of Objects appearing at a Distance; now the greatest Part of these arise from Commotions of the more dense Air that is near the Surface of the Earth, by the Rarefactions of some Parts of it, caused by Heat; which rarified Parts ascending, do make the Objects seen through it, to seem to dance and undulate, which is in great Part avoided, if the Prospect be from an higher Place. Besides, the Nature of the Air itself, at great Heights, approaches nearer to the Nature of the *Æther*, which more powerfully propagates the Impulses of Light.

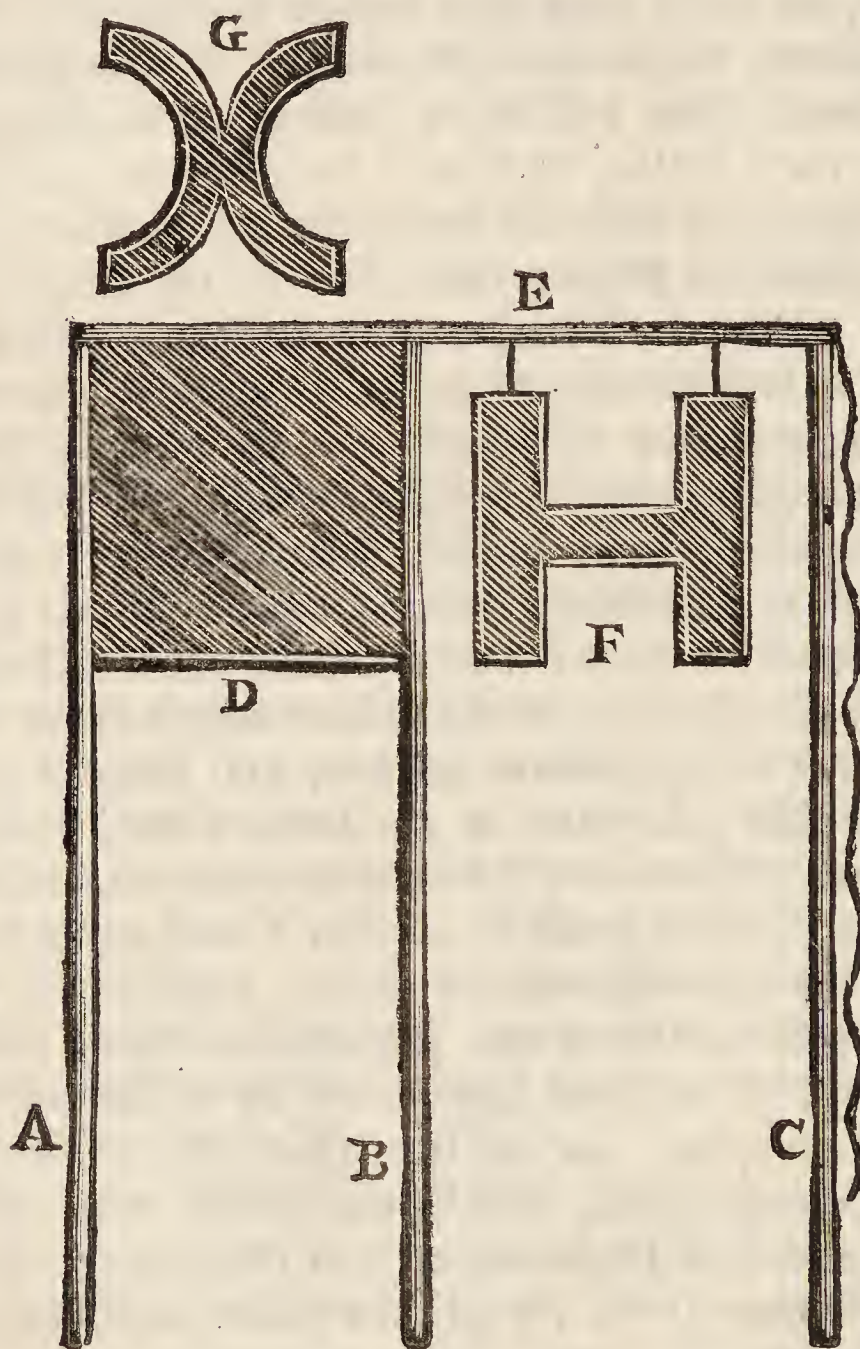
NEXT, in chusing of these Stations, Care must be taken, as near as may be, that there be no Hill that interposes between them, that is almost high enough to touch the visible Ray; because in such Cases, the Refraction of the Air of that Hill will be very apt to disturb the clear Appearance of the Object, as I have often observ'd.

THE Stations being found convenient, the next Thing to be consider'd, is, what Telescopes will be necessary for such Stations. And though 'tis true in all, that the longer the Telescopes are, provided they are good, the better they will be for this Effect; yet somewhat of Limitation is requisite, at least, that they be not shorter than certain Limits for several Distances. These may be as follows: For 1 Mile, 1 Foot; for 2 Miles, 2 Foot; for 3 Miles, $3\frac{1}{4}$ Foot; for 4 Miles, $4\frac{1}{2}$ Foot; for 5 Miles, 5 Foot 10 Inch. for 6, $7\frac{1}{4}$ Foot; for for 7 Miles, 8 Foot 9 Inch. for 8, $10\frac{1}{2}$ Foot; for for 10 Miles, 13 Foot, and so forward. One of these Telescopes must be fix'd at each extreme Station, and two of them in each intermediate; so that a Man, for each Glass, sitting and looking through them, may plainly discover what is done in the next adjoining Station; and, with his Pen, write down on Paper the Character there expos'd, in their due Order; so that there ought to be two Persons at each extreme Station, and three at each intermediate; so that, at the same Time, Intelligence may be convey'd forwards and backwards.

NEXT, there must be certain Times agreed on, when the Correspondents are to expect; or else there must be set at the Top of the Pole, in the Morning, the Hour appointed by either of the Correspondents, for acting that Day; if the Hour be appointed, Pendulum Clocks may adjust the Moment of Expectation and Observing. And the same may serve for all the other intermediate Correspondents.

NEXT, there must be a convenient *Apparatus* of Characters, whereby to communicate any Thing with great Ease, Distinctness and Secrecy. There must be therefore, at least, as many distinct Characters, as there are necessary Letters in the Alphabet that is made use of, (as is expressed in *Fig.*

1.) And those must be either Day Characters, or Night Characters: If they are to be made use of in the Day-time, they may all be made of three slit Deals, moving in the Manner I here shew, and of Bigness convenient for the several




Distances of the Stations for which they are made, that they may be visible through the Telescope of the next Station. Any one of which Characters may signify any one Letter of the Alphabet, and the whole Alphabet may be varied 10000 Ways; so that none but the two extreme Correspondents shall


shall be able to discover the Information convey'd; which I shall not now insist on, because it doth more properly belong to Cruptography. If the Characters are for the Night, then they may be made with Links, or other Lights, disposed in a certain Order, which may be veiled, or discovered, according to the Method of the Character agreed on; by which, all Sorts of Letters may be discovered clearly, and without Ambiguity.




THERE may be various Contrivances to facilitate and expedite the Way of displaying and exposing these Characters to View, and of withdrawing, or hiding them from the Sight; but this I here shew, I conceive, will be as easy and simple as any: All which may be exposed at the Top of a high Pole, and by two small Lines moved at the Bottom, so as to represent any Character.

BY these Contrivances, the Characters may be shifted almost as fast, as the same may be written; so that a great Quantity of Intelligence may be, in a very short Time, communicated.

THERE will be also requisite several other Characters, which may, for Expedition, express a whole Sentence, to be continually made use of, whilst the Correspondents are attentive and communicating. The Sentences, to be express'd by one Character, may be such as these, in *Fig. 2.*

 *I am ready to communicate.*  *I am*

ready to observe.  *I shall be ready presently.*

 *I see plainly what you shew.*  *Shew the last again.*  *Not too fast. Shew faster. Answer me presently. Dixi. Make Haste to communicate this to the next Correspondent. I stay for an Answer; and the like.*

ALL which may be express'd by several single Characters, to be expos'd on the Top of the Poles, by themselves, in the following Manner, so as no Confusion may be created thereby.

I COULD instance in a hundred Ways of facilitating the Method of performing this Design with the more Dexterity and Quickness, and with little Charge; but that, I think, will be needless at present, since whensoever such a Way of Correspondence shall be put into Practice, those, and many more than I can think of at present, will of themselves occur; so that I do not in the least doubt, but that with a little Practice thereof, all Things may be made so convenient, that the same Character may be seen at *Paris*, within a Minute after it hath been expos'd at *London*, and the like in Proportion for greater Distances; and that the Characters may be expos'd so quick after one another, that a Composer shall not much exceed the Exposer in Swiftnefs. And so great Expedition may not only be performed at the Distance of one Station, but of a hundred; for supposing all Things ready, at all those several Stations, for Observing and Expos'ing, as fast as the second Observer doth read the Characters of the first Exposer; the second Exposer will display them to the Observer of the 3d Station, whose Exposer will likewise display them for the 4th Observer, as fast as his Observer doth name them to him, or write them down.

THERE may be many Objections brought against this Way of Communication; and so many the more, because the Thing has not yet been put in Practice. But, I think, there can hardly be any so great, as may not easily be answered and obviated.

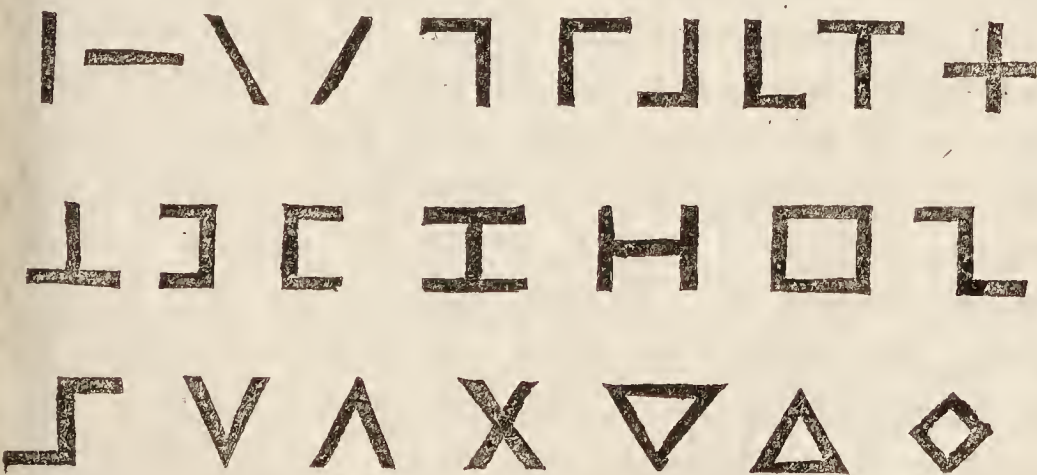
T H E R E

THERE may be many USES made of this Con-
trivance, wherein it will exceed any Thing of this
Kind yet practised ; but I shall not now spend
Time to enumerate them ; only in two Cases, it
may be of inestimable Use. The first is for Cities
or Towns besieged ; and the second for Ships upon
the Sea ; in both which Cases, it may be practised
with great Certainty, Security, and Expedition.

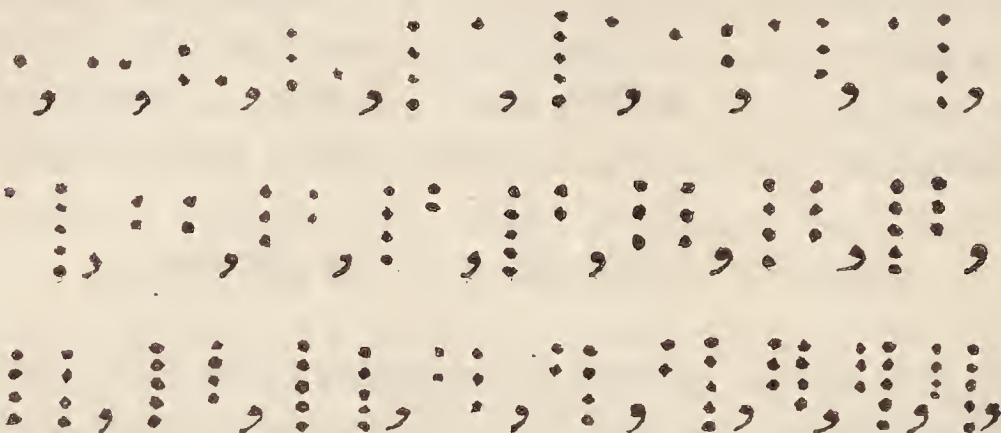
A farther Explication of the Figures.

LET A B C (*Fig. 1.*) represent three very long
Masts or Poles erected. E the Top-piece, that joins
them all together. D, a Screen, behind which, all the
Deal-board Characters hang upon certain Rods or
Lines, and may (by the Help of small Lines com-
ing down from the Bottom of each of them) be
exposed at F, or drawn back again behind D, as
Occasion shall be. G is the Character for a Sen-
tence agreed on, &c.

The Letters of the Alphabet in Characters, Fig. 2.



ALL the Alphabet, or requisite Characters, may be distinctly, and without Ambiguity, expressed. Such a Disposition as this, which I have here describ'd, I think, will be sufficient.



Dr. H o o k's Discourse of Carriages before the Royal Society, on Feb. 25. 1684-5. with a Description of Stevin's Sailing Chariot, made for the Prince of Orange.

THE Occasion of this following Discourse was from the Module of a *Waggon*, shew'd to the *Royal Society*; upon which *Dr. Hook* discoursed largely on the various Ways of Conveyance. Among all which he saith, But that which excelled any, that has hitherto been done of that Kind, was the Sailing Chariot, made by *Simon Stevin*, for the Prince of *Orange*, which, in two Hour's Time, ran upon the Sand, on the Sea-Shoar, by the Strength of the Wind, forty two Miles, carrying in it no less than 28 Men, with Safety and Security: Of which I have seen the Description, and have had the full Account. But this being only accommodated for such smooth Ways, as the Sand on the Sea-Shoar, could not be made for common Use, and has therefore been laid aside and disus'd. However, since there is a Possibility of such

such a Performance, it may, perhaps, be worthy Consideration and further Enquiry, whether it may not be possible to contrive, and make some other Kind of Chariot, or Carriage, which may perform as much in any other passable Ways; which, I conceive, would be of vast Benefit to Mankind.

THE Principal Matter, wherein it differ'd from all other Sorts of Land-Carriage, was this, That instead of making Use of the *Strength* of *Men*, or of any Sort of *Animal*, he made Use only of the *Strength* of the *Wind*, and that after the same Manner as it was then made Use of, for the moving of Vessels upon the Water; namely, by having Masts, Sails, and other convenient Rigging, as Shrouds, Stays, Sheets, Booms, and all other Rigging, as was necessary for the Management of those Sails. Then, for guiding this Engine, he so order'd his Contrivance, that he could, by turning the Axle-tree of the Wheels, make it go this Way, or that Way, at Pleasure, with as much Ease and Certainty, nay, very much more than 'tis possible to steer a Ship, or any other Vessel upon the Water. To keep it safe and secure from overturning, though on so smooth a Plain as that passed over, there was little Danger from the rising of the Wheels on one Side; yet, in the first Attempts, it being better to overdo, in making Provisions against any Thing of Danger, he placed the Wheels at a great Distance, or Breadth, one from another; and, as I judge by the Draught, very near half the Length of the whole Carriage; by which Means there could be no Manner of Danger in over-setting; and still the less, the more the Carriage was loaden, if the Danger of over-setting were to be feared from the Strength of a side Wind upon the Sails; for the Wheels being placed at a pretty Distance without

the Body of the Carriage, all the Weight of the Carriage, together with the Weight of two of the Wheels, and all the Weight of the Men must be lifted up, and rest upon the two Wheels on the Leeward Side, which neither Sails nor Masts would be able to do.

THE Way of steering or guiding this Carriage, was much the same with that which is, and has always been practised in Carriages upon 4 Wheels; namely, an Helm, or Pole, so fastened to the *Axis*. that by the Means thereof, as by a Leaver, the *Axis* could be swashed either this Way, or that Way, upon a Center-Pin, as is now in Use in Coaches and Waggon, for the turning or swashing of the Fore-*Axis*; only, whereas the Pole, in these, is turned and extended Outwards, before the Carriage, in this, it was turned Inwards. The Wheels are about a middle Size, between the usual Size of the fore and hind Wheels of a Coach, and were made very strong and substantial; and what was peculiar in them, was, that the Rims of them were 18 Inches, or 2 Foot broad, and the Spokes were made to strengthen the whole Breadth; the Reason of which I suppose was, that they might thereby be the better able to rest upon the sandy Shoar, without sinking, or making Rotes in it, which would have made it move very much heavier, the Wheels being thereby always in a rising Motion; for the Weight of the whole Carriage, and the Weight within it (which must be very considerable, there being 28 Persons in it) resting only upon the four Points of the Wheels; if they had been made with narrow Rims, must necessarily have sunk pretty deep into the Sand; but being broad, and the Sand very smooth, as it is generally left by the Sea, a small sinking of the touching Line of the Breadth of the Wheel, doth presently make a very broad Footing, to rest upon the Sand.

T H E R E

T H E R E were two of these Chariots made, the one a larger, of about 30 Foot long, and the other a smaller, about 10 or 12 Foot long: The larger had two Masts and two Sails, proportionable to the Sails of a Boat, much about the same Bigness. The lesser had only one Mast and one Sail, proportioned likewise to its Bigness. Each of the Sails had two Yards, the one at the Top, and the other at the Bottom, with proper Rigging to work them. The Bottom Yard, I conceive, was put upon a double Account, First, to keep the Sail more flat and plain, that it might, when the Carriage was to sail near a Wind, be kept more sharp and trim; the great Advantages of which I endeavour to prove upon another Occasion. And Secondly, That the Sails might be the easier managed, and tacked, as Occasions should require. And though I cannot find, whether this Engine was ever tried, or made Use of, for Sailing by a Wind; yet, I doubt not, but that it would have far exceeded any Vessel whatsoever, that sails upon the Sea, in going near a Wind; because, that in this, there could be no falling to *Leeward*, (which the best Vessels on the Sea do more or less) the Wheels, in this, keeping it directly in the Line, or Plain of the Wheels.

T H E greater Carriage was guided, or steered, by moving the hinder Wheels by a Pole, like the Helm in a Ship, and the End of it had Tackles to bend it towards this or that Side; and the Rule of Steering was the same as in a Ship. The lesser Carriage was steered by moving or turning the Axis of the fore Wheels; the Pole or Helm being turned backward into the Carriage, and the Rule of Moving it was also the same as the former.

T H E last Thing to be considered in these Carriages, is the great Swiftnefs of their Course, which was so considerable, that no Horses, in their full Speed,

Speed, could long keep Pace with them; and Vessels on the Sea, sailing the same Way, seem to be carried backwards very swiftly. This, had it not been attested by Testimonies of undoubted Credit, would have seem'd very difficult to be assented to. But, on the other Side, if we consider the advantageous Circumstances for its Promotion, and speeding forward, and the small Impediments for the hindering these Carriages had, beyond any other, we shall find much less Reason to doubt the History of it: For, if we compare it with Vessels sailing upon the Sea, we shall find that this Carriage has first a plain, hard and even Surface of the Shoar to pass over, without any Rub or Impediment; so that it is moved in a Plain without rising or falling, without any unequal Impediment, save only some small Matter in the rubbing of the Ends of the Axes in the Naves of the Wheels, which, being well oiled, will be very little; whereas a Ship at Sea, when there blows a stiff Gale (which is absolutely necessary, when much Speed is desired) is first clogg'd in its Motion by the Lentor and Difficulty of yeilding in the Medium of Water; by the unequal Stoppings of the rising Waves, which create an undulating and unsteady Motion Upwards and Downwards, as well as Side-ways; besides the Slope falling and sliding away to Leeward, which must be allow'd for in all Side-Winds, by steering some Point nearer the Wind, than the direct Way; and consequently the Length, passed by the Vessel, will be as much longer than the direct Distance, as the Secant of such an Angle is than the Radius. On the other Side, if we compare its Motion with that of a Carriage drawn by Horses, or other living Creatures, it plainly appears that these were moved by an unwearied Strength, whereas the Horses were not long able to hold that Pace. So
that

that upon the whole, it seems to be the swiftest Carriage yet known, for so great a Burthen, and so long a Way.

BUT the great Objection against this Invention is, that it is hardly practicable in any other Place, and even there but at certain Times, which possibly have been the Reasons, why it has been so long disused, and almost forgotten. To which I answer, That scarce any other Invention for Carriage is practicable in all Places: Land Carriage cannot be practised at Sea, nor Sea Carriage by Land; Carts and Coaches cannot be used in some Places, by reason of the Inconvenience of the Ways, as in *Cornwall*. But this Invention, I conceive, is not to be thought confined only to the smooth Sands on the Sea Shoar; for I doubt not, but that if Trial were made (as I hope it will shortly be) it might be much more practicable upon the plain Downs of *England*, than where it was used, by Reason they are much more exposed to the Wind, and also much more hard, so that the Wheels need not be of so great a Breadth. I conceive farther, that the Carriage may be improved much in its Lightness, and also in the Easiness of moving. If such a Chariot were made for *Salisbury Plains*, *Banstead Downs*, *Winchester Downs*, *Newmarket Row*, or some such smooth Plains, and the Wheels, (which need be but three) were moved upon small Steel *Pevots* or *Gudgeons*, in *Bell-Metal Sockets*, well oiled, instead of being moved upon the large End of an *Axle-tree*. Next, if instead of 4 Wheels, 3 only were made use of, placed in the Form of a Triangle, the steering Wheel being that which went foremost, and the Place of the Mast in the Center of the Triangle, the Weight carried, to be all placed behind the Mast, to which I would also have added a Contrivance to retard and stop its Motion,

Motion, whenever there shall be Occasion, which is easily to be done; somewhat after the same Manner as Windmills are stay'd, when there is Need. By such a Contrivance, I doubt not, but a Chariot may be made to out-run even the swiftest Race-Horse, especially where the Course is long and plain; and with a Side Wind may be carried back again to the Place from whence it set out; and both forward and backward may be carried with as great a Swiftneſs, even as the Wind moves, which will not be unpleasant to ſuch as have ſuitable Conveniences near their Habitations; with which may be tried as many Experiments of ſailing near a Wind, as can be tried upon the Sea; the Contrivance of the Wheels making the Motion as eaſy, as the Water of the Sea or Rivers in others; and to a very ſwift Motion, having much leſs of Impediment, eſpecially if the Wheels be order'd to the beſt Advantage, all Manner of rubbing or ſliding being thereby taken off, and even the Inequality of the Ways themſelves may be in a great Meaſure removed. I have been the more particular in deſcribing this Carriage, becauſe it was the ſwifteſt that has poſſibly yet been made, and therefore, on this Occaſion, deſerved more than a tranſient Mention, tho' I do not look upon it as an Invention of the higheſt Perfection, for this Effect; but may be as much exceeded, as that exceeded a Man that leiſurely walks. Who it was that firſt invented the Wheel, is not recorded in Hiſtory, it having been long before any Hiſtory extant (except that of the Bible) and the firſt Mention we find of it there, is *Pharaoh's Chariot*, in which *Joſeph* was exalted to ride: Of whoſe Form we know nothing but the Name, tho' it had, in Probability, been known long before that Time; which, notwithstanding, long preceded any Hea-then Writings now extant.

Hyginus relates, in his 2d Book, where he treats *De Ophiucho*, that *Ceres* invented an One-Wheel'd Chariot, which *Triptolemus* (whose Nurse she was) first made use of, for to make Speed, to inform the World of her Bounty. *Ceres cum sua beneficia largiretur hominibus, Triptoleum cuius ipsa fuerat nutrix (qui primus hominum una rotâ dicitur usus ne cursum moraretur) iussit omnium nationum agros circummeuntem semine partiri.* In *Glossis Isidori*, *Vehiculum unius rotæ*, is called *Pabo*. But how this One-Wheel'd Chariot was contrived, or used, is not to be found in History; Mention there is, of other Chariots, with more Wheels, in the ancient Authors; so that 'tis clear, it was known and practised long before any Histories of Heathen Writers were publish'd. An Invention of so great Use, that it seems impossible ever to be lost by Mankind, after it be once known: Which Consideration makes me very much wonder whence those Men came, that inhabited *America*, before the *Spaniards* over-running and conquering of it; since it seems probable, that if they, or their Ancestors, had sprung from any People here, on this Side of the World, *viz.* from *Europe*, *Asia* or *Africa*, they must needs have carried along with them the useful Invention of the Wheel; but it has been observed, that they knew nothing at all concerning it, nor any the least Use of it, throughout all *America*, before the *Europeans* came among them. So that we must conclude, either that they were made Inhabitants before the Invention of the Wheels was found, or that they never had any Origination from any Generation of Men in those Parts of the World, at least not from the *Tartars*, who, of all People, do most frequently use them; but this by the by. The first, and most simple of *Carriages* by Land, was this Invention with one Wheel, and may possibly be most accommo-

accommodate, for attaining the End we are now inquiring after, which is Swiftnefs, it having the least Impediment to its Motion, and the least Incumbrance of any other; and may therefore, in the next Place, deserve to be considered, and possibly be brought into common Use, at least to be experimented, as was that of the Sailing Chariot.

BUT before I come to the more particular Description thereof, I think it will not be impertinent to examine the Contrivance of the Wheel, as it is applied to Carriages, for the facilitating of their Motion. One of the greatest Obstructions to Swiftnefs of Motion being the Inequality of the Ways, and the rubbing or grating of those Ways against those Bodies or Weights, that are drawn or slid upon them.

THE Wheel being then a round Body, and moving forwards, only by its Rollings, doth not at all rub, grate, or slide upon the Way; and so hath no Impediment at all to its Motion forward, where the Way is even, plain and horizontal, or level, there being no Impediment, or very little, from the Medium of the Air it passes through, and so hath no Impediment to be moved with the swiftest Motion, like that of the Resistance of Water to Vessels moving through it: So that the only Impediment seems to be that of its own Bulk, (of which I shall speak hereafter) because the outward Rim of the Wheel, in its rolling Motion, doth uniformly apply its Parts to the Parts of the Plain, by descending down, and rising up from them perpendicularly; and the touching Part is always quiescent upon the Plain, and moves not either forward or backward; and consequently all Impediment from rubbing upon the Ground or Way is wholly taken off, as 'twill be evident to any one who shall examine the Motion of any one Point of the Verge of the Wheel; for he will find

find that every Point of this Verge doth, by the compounding the circular and progressive Motions together, move itself in a true *Cycloidal* Line, and that, in the Point of touching it, resteth or standeth still in the Boundary between two such Lines. So that where the Plain and the Wheel is perfectly hard and smooth, the Wheel receives no Impediment to its compounded Motion ; but it may be thought that the circular Motion of the Wheel is an Impediment to the progressive Motion, because by Means of this Composition, the Parts of the Wheel do, in several Positions therein, receive several Degrees of progressive Motion, and so seem to go, as it were, by Starts, for that the Points, whereby they touch, have no progressive Motion at all ; and when they are at the Top, or at the greatest Distance from the Plain, they have a double Velocity forwards, compared to that of the Center, and, in every intermediate Position, a differing Degree of Velocity forward. But this is no Impediment at all to the progressive Motion of the Whole, each Motion being severally uniform, equal, and continued. For a *Pendulum*, whose Weight at the End is a Globe of Lead, or any other ponderous Body, suspended by a String, receives the same *impetus* from the Power of Gravity, (which is the same in both Cases) whether this Globe, so suspended, be suffer'd to vibrate, whilst it be swiftly whirled round upon its Center, or whether it be not so whirled at all, the compounding of Motions not at all intermeddling with one another ; but every one keeping its distinct *impetus*, as may be easily found by Experiment, if Trial be made in the Way I propose. Whence I conceive also, that the periodical Motion of the Earth, or any other Planet about the Sun, would be the same, whether the Body of any of them were gyrated round their own Centers, or not,
and

and whether the *Axis* of that Gyration were at right Angles with the Plain, in which they are mov'd or not, the Motion or Influence of the one not at all interfering, or disturbing that of the other. But this only by the by. However, I think it may be pertinent to be consider'd in the Examination of an *Hypothesis* of Gravity, propounded by the learned Dr. *Vossius*, in his lately publish'd *Miscellaneous Treatise*, wherein he lays great Stress upon the Position of the *Axis*, in respect of the Plain of its circular, or direct Motion.

NEXT, we are to consider, what Impediment to its Motion, a Wheel, thus roll'd upon a Floor, receives from that Floor. There may be two impediments then, that a Wheel, so roll'd, may receive from a Floor according to the Nature thereof. The first and chiefest, is the yielding, or opening of that Floor, by the Weight of the Wheel so rolling and pressing; and the second, is the sticking and adhering of the Parts of it to the Wheel; to which two may be referr'd all others, all of which proceed from the yielding or giving Way of the Parts of the Floor, and the not returning again to their bended Posture; for, if the Floor be perfectly hard (as also the Parts of the Wheel) tho' it be very unequal, yet is there little or no Loss, or considerable Impediment to be accounted for; for whatever Force is lost, in raising or making a Wheel pass over a Rub, is gain'd again by the Wheel's descending from that Rub, in the same Nature as a Ship on the Sea is promoted by the descending down of a Wave, as much as impeded by its ascending, or a *Pendulum* is promoted by its Descent, as much as impeded by its Ascent.

NOR is the yielding of the Floor any Impediment, if it returns and rises against the Wheel, for the same Reason; but the yielding, or sinking of the Floor, and its not returning again, is the
great

great Impediment from the Floor ; for so much of Motion is lost thereby, as there is Force requisite to sink such a Rut into the said Floor by any other Means ; whether by Weight, Pressure or thrusting directly down, or any Ways obliquely.

AND it may also be calculated, by drawing on the Wheel, whose Weight, at the mean Time, sinks the Floor it rolls over. Either Way it will be easy to bring it under Calculation, which is the Design of this Discourse.

THE Second Impediment it receives from a Floor, or Way, is the sticking and adhering of the Parts of the Way to it ; for by that Means, there is a new Force requisite to pull it off, or raise the hinder Part of the Wheel from the Floor, or Way, to which it sticks, which is most considerable in moist clayie Ways, and in a broad rimm'd Wheel. For in such Ways, the Wheel doth not only lose a Part of its Motion, by the yielding and pressing of the Clay against the fore Parts of the Wheel, but by the cleaving to, and holding of it to the hinder Parts, which makes all Carriages move very sluggishly and heavily in such Ways.

THUS much I thought necessary to consider, as to the Goodness or Badness of the Floor, or Ways over which Carriages are to pass, whereof, in the general, this may be affirm'd, that the harder the Ways are, the less Impediment they give to the Motion of Carriages over them ; and the more even they are, the more equal is the Motion.

HITHERTO I have consider'd the Wheel only as free, and, of itself, burthen'd only by its own Weight. I shall next consider it as burthen'd by another Weight. There are two Ways then of burthening a Wheel. The first is, by laying the Weight at the Top of it ; the second is, by laying it upon the Center, or Axis of it.

THE first Way was possibly the first invented, being of great Use for transporting of very great Weights some short Way, and is generally practised for removing of Obelisks, Columns, great Stones, or Great Beams of Timber ; and, for that Use, the Rollers, or Wheels, are generally solid Pieces of hard Timber, cut or turn'd round ; and are very long or broad, call'd Rollers ; this, of all Ways, is the easiest for removing such Weights ; but then they must be continually chang'd by being remov'd from behind the Weight, and plac'd before ; for as they roll forwards upon the Floor, so they roll backwards under the Weight, or rather promote the same with a double Velocity to that of their own upon the Floor. By the Way, it seems very strange, that the *West-Indians*, tho' in their Buildings they made use of such vast Stones, and dragged them on the Ground for so great a Distance, yet that they should not understand the Use of these Wheels, or Rollers, which, Histories say, they did not, they performing those Transportations only, by the main Strength of Men pulling at the Ends of a great Number of Ropes. By this Way, a vast Weight may be moved by a very small Strength, if all Things be hard and smooth, approaching much to the moving of a Bulk upon the Water ; but this being more proper to be enlarged upon under the Head of Strength, and not so adapted for Speed, I shall leave at present, till I speak of that Part.

THE second Way then of burthening Wheels, is, by resting such Weight upon the Axis, or Center of them ; This may be, and has been practised also two Ways ; that is, either first, by making the Wheel move round upon the Axis fixed to the Carriage ; or, secondly, by fixing the Axis to the Wheel, and making the Axis to turn round in a Socket of the Carriage ; the first of these

these Ways is new, and has always been the Way of using Wheels for Chariots, Carts, Waggon, and such other Kinds of Carriages; the second, is used in Wheel-Barrows, and such other Carriages and Uses, where the Wheel runs within the Frame. Of these two Ways, the last (where it can be applied) is much the best; for that the Axis can be much better fixed in the Wheel, so as to make it run true in a Plain; and next, for that the Axis may be kept more firm and steady to that Motion, by having the two Ends of the Axis, by Means of its Gudgeons, kept in the Sockets fitted for it; and thirdly, because the Gudgeons, halving the Weight, may be made very much smaller, and so will not cause a tenth Part of the Friction which is necessary in the other Way. This second Way, therefore, is much better accommodated for Speed than the former, and may also be well enough contriv'd, to be made applicable to several Sorts of Carriages fit for that Purpose, of which I shall hereafter speak.

THE next Thing to be consider'd, is the Make of the Wheel itself; which has been several Ways contriv'd, and made use of in differing Ages of the World, and for differing Occasions. The first and most simple, was that which was made of a round Piece of Timber for Rollers, as I noted before, in which there seem'd to be little of Art, but only sawing it off with a Saw; these were of the smallest Sort, and are still used for Truckles and smaller Carriages.

THE Second, was that of a somewhat bigger Sort, and that was either cut out of a whole Plank, where it cou'd be procur'd broad enough, or else was made of two or more Planks join'd together, and fasten'd by two or more, cross Ledges, and that was call'd *Tympanum*, and the same is still used for the Carriages of Guns at Sea. The

third Way, was of bending a Piece of pliable Timber, as we now do for Hoops, and thereby making the Rim of the Wheel all of one Piece, and fixing the Spokes to it, which were also fix'd into a Nave in the Middle; which Nave was also turn'd and bor'd, as the Naves, we now use, are.

THE last, and most practicable of all, was that we now use, whereof the Rim was made with several Fellows join'd and yok'd together with Pins, and sometimes with Joints, and strengthen'd also by the Sides with Irons, and, after all, bound round with Iron Streaks and Nails. This Way is used for all Sort of Carriages, whether heavier or lighter; and Wheels, thus made, are differenced only by being made either bigger or less in Compass, or stronger and weaker in Substance or Bulk; whence they become also thicker or thinner, in Breadth or Thickness, and also heavier or lighter, according to the various Designs and Uses they are apply'd unto; the Circumstances and Accidents, that concomitate their design'd Use, best directing the Artift in the Contrivance of their Form and Make.

I SHALL not now insist upon explaining, which Sort is most proper for every of these Designs, because I shall do that under each proper Head; but shall only consider at present, which Kind of these are best for Speed and Celerity, that being the Head I am now explaining.

FOR making of Speed then, those Sorts of Wheels are best which are the biggest in Circumference or Diameter, because first, a much greater Part of the Rim doth bear at once, than in a Wheel of a less Circumference; for the Way being always more or less yielding, the bigger Wheel sinks in so much less to come to its bearing, than the lesser Wheel, by how much the greater Circle approaches nearer to a streight Line, or the Tan-
gent

gent of the Floor. Secondly, Because the greater the Arch, the more easy is the Rise of the Wheel over any Irregularity, or Rub in the Way, and the easier the Fall, and thereby approaches nearer to the evening and plaining of the Way, and makes less Inequality in the Draught. On the Contrary, the smaller the Wheel, the worse, for that it introduces all the contrary Inconveniences. Thirdly, The larger the Wheel is in Circumference, the less is the Impediment of the rubbing and wearing.

FOR *First*, the Leaver of the Spoke is so much the longer, and so the Nave will turn so much the easier upon the End of the Axle; the Weight born, in both Cases, being the same, and consequently the Bigness, both of the one and the other, needing not to be differing.

Secondly, THE lighter the Wheel be (provided it be made strong enough to perform the Business it is design'd for) the better it is; and therefore all Manner of Contrivance that tends to the making the Wheel strong, and yet large and light, is to be made use of, for that thereby a less Weight is necessary to be moved, and consequently the same Strength will have the greater Effect.

Thirdly, THE less rubbing there be of the Axle, the better it is for this Effect; upon which Account, Steel Axes, and Bell-Metal Sockets, are much better than Wood, clamped, or shod with Iron; and Gudgeons of hardened Steel, running in Bell-Metal Sockets, yet much better, if there be Provision made to keep out Dust and Dirt, and constantly to supply and feed them with Oil, to keep them from eating one another; but the best Way of all is, to make the Gudgeons run on large Truckles, which wholly prevents gnawing, rubbing, and fretting.

THESE are some of the good Qualifications of Wheels, prepared and adapted for the Design of Speed, which I am now discoursing of: There are some other Qualifications that yet exceed these, of which I shall treat some other Time, where I shall have Occasion to apply them.

HAVING thus far consider'd of the Properties and Qualifications of Wheels, fit for such Carriage, I shall next consider what Kind of Carriage is best for this Purpose, and what Number of Wheels are fittest to be applied.

First, FOR the Properties of the Carriage. That which is of the smallest Bulk, and of the lightest Weight, and of the simplest, plainest, and yet strongest and most durable Structure, is the best; provided still, that, in every Particular, it be sufficient for performing what is required of it. That Carriage, which is only design'd for carrying a single Man, should not be made either large enough, or strong enough, or heavy enough, to carry two; that, which can be born by one or two Wheels, should not be loaden, or clogged, with two, three, or four. So that upon the whole Matter of the Instrument, fit for Conveyance of one single Person, I see none can be better than a certain Carriage or Chariot, and for the convenient Reception of one Man, and resting or moving upon one single Wheel. I do not find this to be in Practice any where, but in *China*, of which there is a short Account in *Martinius* his *Atlas Sinicus*. But this is not so well adapted for Swiftnefs, being moved by the Strength of Men, and, for the most Part, by one, and so is only a Chair, or Sedan, with one Man and a Wheel, instead of a second Man; but might be contrived much better, both for Ease and Speed, if there were two Men made use of with one single Wheel, which I shall elsewhere describe; but

but still it will come short, as to Speed, in Comparison to one, wherein the Strength of Horses, or some such swift and powerful Mover, is applied for its Acceleration.

THE next Thing then to be considered, in an Engine for Speed, is the Application of Strength for the moving thereof, which is the Life of the whole ; and without which, all the rest is motionless. This I shall discourse of the next Time.

[I do not find any Account, among Dr. Hook's Papers, of the Matters here promised.]

WILLIAM DERHAM.



The Number of Houses paying Chimney-Money in every County of England and Wales, in the Year 1685.

| | | | |
|----------------------------|-------|--------------------------|---------|
| <i>Bedfordshire</i> - - - | 12170 | <i>Nottingham</i> - - | 17554 |
| <i>Berks</i> - - - - - | 16906 | <i>Oxford</i> - - - - - | 19007 |
| <i>Bucks</i> - - - - - | 18390 | <i>Rutland</i> - - - - | 3263 |
| <i>Cambridge</i> - - - | 17347 | <i>Salop</i> - - - - - | 23284 |
| <i>Cheshire</i> - - - - | 24054 | <i>Somerset</i> - - - - | 44686 |
| <i>Cornwall</i> - - - - | 25374 | <i>Suffolk</i> - - - - - | 34422 |
| <i>Cumberland</i> - - - | 14825 | <i>Surrey</i> - - - - - | 14273 |
| <i>Derbyshire</i> - - - | 21155 | <i>Suffex</i> - - - - - | 21537 |
| <i>Devonshire</i> - - - | 56310 | <i>Stafford</i> - - - - | 23747 |
| <i>Dorsetshire</i> - - - | 21944 | <i>Warwick</i> - - - - | 21973 |
| <i>Durham</i> - - - - - | 15984 | <i>Wilts</i> - - - - - | 27093 |
| <i>Essex</i> - - - - - | 34819 | <i>Worcester</i> - - - - | 20634 |
| <i>Gloucestershire</i> - - | 26764 | <i>Westmorland</i> - - | 6501 |
| <i>Hampshire</i> - - - | 26851 | <i>York</i> - - - - - | 106151 |
| <i>Hertfordshire</i> - - - | 16569 | | |
| <i>Herefordshire</i> - - - | 15006 | | 986765 |
| <i>Huntington</i> - - - | 8217 | | |
| <i>Kent</i> - - - - - | 29242 | <i>Wales</i> - - - - - | 42565 |
| <i>Lancashire</i> - - - | 40202 | <i>London</i> - - - - - | 30997 |
| <i>Leicester</i> - - - - | 18702 | <i>Middlesex</i> - - - - | 54287 |
| <i>Lincoln</i> - - - - - | 40590 | <i>Westminster</i> - - - | 14852 |
| <i>Monmouth</i> - - - - | 6490 | <i>Southwark</i> - - - | 19945 |
| <i>Northampton</i> - - - | 24808 | <i>Bristol</i> - - - - - | 5122 |
| <i>Norfolk</i> - - - - | 47180 | | |
| <i>Northumberland</i> - | 22741 | <i>Total</i> - - - - - | 1154533 |



Experiments and Observations for the Improvement of the Barometer, by Dr. Hook, read before the Royal Society, Feb. 3. 1685-6.

THE Experiments I have now shewn, are no Ways pompous and surprising. Such possibly may better suit a Stage or Theatre, for vulgar Spectators to admire and gaze at, who are most taken with Shew. But these are plain and obvious, and only valuable, as they discover some Truth, that may be either useful of itself to be known, or has a Tendency to the making some farther Discovery, or of being useful, as preparatory to some other Experiment or Invention, which may be made or founded thereupon. And indeed the greatest Part of Experiments, if they be not made for some such Design; and the material Circumstances, useful thereunto, diligently enquired after, and strictly observ'd, and brought to a Calculation for that Purpose, do serve for little else than to hint an Experiment to some other to try, who may have some Use or Application for it.

THE Experiments, as they have been made, do exhibit the specifick Weight of the fluid Bodies; together with their comparative Weight with Water: That these three Fluids are in specifick Gravity to one another, as follows.

Water, 5997.

So Water to *Mercury*, as 1 to 15.

Spirit of Wine, 5102.

Oil of *Turpentine* to *Mercury*, as 1 to 17½.

Oil of *Turpentine*, 5209.

Spirit of Wine to *Mercury*, as 1 to 17.

FURTHER

FURTHER Observables are,

First, THE great Lightness of Spirit of Wine, and Oil of *Turpentine*, they being, Spirit of Wine but as 51. Oil of *Turpentine*, 52, whereas common Water is 60; that is, almost a sixth Part lighter than Water.

Secondly, THE Nearness of their specifick Gravity to one another, which may be yet made as much nearer, as shall be requisite, or desired, by the intermingling Water, or Flegm, with the Spirit of Wine; for the Spirit of Wine being lighter, and the Oil of *Turpentine* heavier, some Mixture of Water, with the Spirit of Wine, will bring the Spirit of Wine to be as near of the same Weight, with the Oil of *Turpentine*, as shall be required.

Thirdly, THE differing Nature of these so seemingly similar Liquors.

First, IN that they will not mix with each other, but will float the one upon the other.

Secondly, IN that they will not easily receive the same Tincture, but differing; the Spirit of Wine readily imbibing a Red, from *Cocheneel*, which that, and the Spirit of *Turpentine*, a Green.

THE Use, or Application of these Experiments, is in Order to the Solution of this following mechanical *Problem*.

How to make a *Barometer*, or Instrument, to try and find the Weight of the Air, at all Times, which shall rise and fall steadily, and without jumping or starting, otherwise than as influenced by the Air, and the hitherto unknown Alterations thereof; whose Limits, between the greatest and the least Height, shall be 10, 20, 30, 40, 50, or more Feet in Perpendicular; and the Motion, in every
Inch

Inch of the said Height, as plainly visible, as the Rising and Falling of an Inch in the common single Barometer.

IT is about 7 or 8 Years since I propounded such a *Barometer* to this Society ; and I cannot expect that many such will be made ; however, possibly it might not be amiss, that this Society, or some curious observing Person, would make one, and diligently remark the Changes and Motions thereof. For it might possibly discover such Changes and Motions of the Air, as we have hitherto no Notion or Conjecture of ; for I did once observe, that the *Wheel-Barometer*, a little before a great Storm of Thunder, Lightening and Rain, did appear to have a tremulous Motion, as if the Room, or Post it hung upon, had shook, when yet the Clouds were but gathering, and were far enough off from this Place, where I observed it ; of which I have, long since, acquainted this Society, and, I conceive, it may be found in the Journal. But there are many other Changes in the Air, that none of the Instruments, we yet have, will detect ; and therefore there may be Scope enough for Inventions, of other Kinds, to detect them, which may give a farther Light to the Discovery of that most significant, and most useful, Body of the Air. And tho' possibly the Invention of a mechanical Instrument may be looked upon as a trivial Thing, yet, as it may be contrived and applied, it may furnish us with a new Sense, by which we may be able to know some Properties of Bodies, of which we have now no more Notion, than one born blind has of Colours, or one deaf of musical Sounds ; or than the whole World hath ever had, of the differing Gravitation of the Air, before the *Barometer* was invented and observed.

THE Reason of my contriving this Instrument, was, that I might shew a Way how the Examination, or weighing of the Air's Pressure, might be carried to the Extreame, or as far as could well be desired ; for so it may be, by this Method, if any one will be at the Charge of making it.

AND indeed if we consider, and a little more strictly examine into the Nature of Things, we shall find, that most of the Operations of Nature are out of the Reach of our Senses, and cannot be plainly, if at all, discover'd by them, and we are left to guess at the Consultations and Designs of the Privy Council of Nature, only by the publick Acts and Effects that are produced thereby ; whereas, if we could by Sense be informed of the Agents, and of the Method or Way of acting, used by those Agents, we should be much better able to give a right Judgment of the Effects.

Now there is no Method of Information so certain and infallible, as that of Sense, if rightly and judiciously made use of. And though the Senses themselves are limited in their Power and Extent, when considered barely in themselves, as naturally constituted, yet their Power may be much enlarged, and their Limits much farther extended, by the Helps that Art may afford, and, most especially, by Mechanicks ; by Means of which, not only each of them may be made more Powerful in the Discovery of the proper Objects of those several Senses ; but each of them may be made a *Genus*, as it were, of new Sorts of Sense, comprised under them, of which we have yet no Notion, nor any Sense or Method of Discovery ; at least they are yet unheeded. I might instance, in the Body of the Air itself, but I shall reserve it to another Opportunity.

In Air, $13\frac{3}{4}$, $\frac{1}{2}$.

In Water, $\frac{1}{2}$ gr. 83.

In Spirit of Wine, $2\frac{1}{2}$, 28 gr.

In Spirit of Turpentine $2\frac{3}{4}$, $2\frac{3}{4}$, 41 gr.

Air 105 $\frac{1}{2}$.

Water $5\frac{1}{2}$, 3 gr. ——— 100 $\frac{3}{4}$ — 3 gr.

Spirit of Wine 20, 28 gr. ——— 85 $\frac{3}{4}$ + 2 gr.

Ole. Tereb. 18 $\frac{1}{2}$, 11 gr. ——— 86 $\frac{3}{4}$ + 4 gr.

WHEREFORE I find that Spirit of Wine may easily be made to be 16 Times lighter than Mercury ; if then the Spirit of Wine be made of this specifick Weight, by intermingling Water with it, and the Height of the Pipes, or the Cylinder of Spirit of Wine be designed to play 32 Foot perpendicular ; then must the mercurial be 2 Foot more in Height, than the common *Barometer*; which I have found sometimes (as particularly on *Wednesday* last) to be 30,6; and consequently the mercurial Cylinder to counterpoise the Gravity of the Air, and the Gravity of a Cylinder of 32 Foot in Height of Spirit of Wine, of such a Rectification as I have specified. Now, the Cylinder of the Spirit of Wine being always the same, that is, 32 Foot, the Counterpoise to it of Mercury will be always the same 2 Foot ; and the Cylinder of the Air only altering the Cylinder of the Mercury also, that counterbalances that also, will only be alter'd, and that the same, as in the common *Barometer*. Now if the Oil of Turpentine be $\frac{1}{8}$ Part lighter than that, then a Cylinder of Mercury $\frac{1}{8}$ shorter than two Foot, will counterpoise it ; which is but one Quarter of an Inch Difference in the counterpoising Cylinders.

Although

Although I find, by the Minutes of the Royal Society, that the learned Dr. Slare had, long before the Year 1677, shewed a Phosphorus; yet it being chiefly about this Time, that most of the Accounts of the Phosphori were sent, I therefore chuse to insert here such Preparations as I have of them. And first of the

W. DERHAM.

Bolognian Phosphorus.

THIS Stone is found in three Places near the City of *Bologna*; the first is called *Pradalbino*; the second is a small Brook near the Village *Roncara*; the third is call'd *Monte Paterno*, and is most noted for these Stones; not only as having the greatest Quantity, but a Sort most easy to be prepared. The Ground thereabouts is barren, yielding Pieces of yellow *Marcasite* of the Bigness of a Nut.

THE properest Time to gather it, is after Rain, when the Surface of the Ground is a little wash'd away. It's known by a Glittering (like that of burnish'd Silver) which surprizes the Eye.

IT was first found out by one of that City, call'd *Vincenzo Casciarolo*, a Cobler, but ingenious, and a Lover of Chymistry; who, trying several Experiments with these Stones, by Chance happened on this Way of preparing them, so as to make them shine in the Dark, after they had been some Time exposed to the Sun.

IT has no certain Figure, some being cylindrical, others round or lenticular; and these last are often the best, as being most shining and transparent.

IT's usually no bigger than an Orange ; and tho' *Licetus* affirms, there never was any greater than that in *Androvandus's Musæum*, weighing about two Pound and half ; yet the Author hath had of five Pound.

IT's very heavy, considering the Bulk, as being probably compounded of several mineral Substances.

THE Colour is various, as Ash, Rusty, Sky, Yellow, Earthy and White ; but the best for Use are Sky-colour and White.

WHEN it's well prepared, it leaves a Lustre in the Superficies, and is enlightened, not only by the Sun, but the Moon, and a Fire ; but by these not so strongly, as the Sun.

THE Light, tho' it appear like a Coal, yet is not sufficient to read with, unless applied close to the Word.

IT will not retain the Light very long, at one Time, nor its Vertue above five or six Years.

THE Preparation is thus: Take a Cylinder, whose Circumference is about two *Roman Architect Palms*, and $\frac{2}{3}$ (of our Measure, almost two Feet) the Height about $\frac{2}{3}$; spread the Inside of the Cylinder with stiff Clay, till the Diameter of the Aperture come to be but $\frac{2}{3}$; on the Top of the Cylinder make four equidistant Notches, about $\frac{1}{3}$ deep, and $\frac{2}{3}$ broad : This being done, take another Cylinder of equal Dimensions with the former, or something taller ; at the Bottom, make two Port-holes, opposite to one another, and capable to receive a Hand ; make a Bottom of the same Clay, which may reflect the Heat. This Vessel being cover'd with a thick Wire Grate, that the Air may easily pass through, and the other Part of the Furnace placed upon it ; lay upon the Grate some lighted Charcoal, and then other not lighted, but well charr'd, and free from Earth, Stones,

Stones, and other sulphurous Matters, breaking the Coal into Pieces no bigger than a Nut ; when you have made your Bed, as high as the Notches, put upon it your Stones, to be calcined, so close, that they must touch ; but first beat some of the Stones to Powder, and searce it in a fine Hair Searce, that it may come out very fine ; when you have wet your Stones, that are to be calcined, in good strong *Aqua Vitæ*, roll them in that Powder, and lay them, as before, on the Charcoal, and make another Bed of Charcoal over them, to the Top of the Furnace, which you cover with a round close Head. When the Coals are spent, and the Stones cool, take the Crust away from them, and wrap them in Silk, putting them in a close Box, till you make use of them.

IF you would make Figures and Representations with this Light, as is often done, take the Crust, which comes off the Stones, and beat it small, searcing it as before ; then when you have made your Figure, or Image, wet it with the White of an Egg, and sprinkle upon it your fine Powder, which will shine like the Stone.

THIS Sort of Furnace is not absolutely necessary, but convenient, as well in determining the Time, as the Degree of Heat ; which, if more, might diffuse that Lustre which is in the Superficies of the Stones ; if less, not raise it.

THE Author, occasionally speaking of shining Woods, delivers this Rule, for the sure finding of them. That an Apple-Tree is the best Wood ; that it must be very dry, or rotten ; that being so, and lying under Ground, that Part under Ground will partake of a shining Quality, which will not last above three Days, nor be recover'd again, when lost.

Phosphorus Liquidus.

SUME falem alcali v. g. cinerum clavellatorum bene purificatum per diversas solutiones & filtrationes, & ab omnibus impuritatibus in unum; deinde in crucibulo novo ad falem albissimum calcinetur, tum in mortario polito & calido in minutissimas partes teratur; deinde indatur retortæ vitreæ cum spiritu urinæ rectificatissimo imbibitus, cui applicetur recipiens bene agglutinatus; tum ignis per gradus admoveatur: hic operatione factâ debet pluries cohobari, addito semper novo spiritu urinæ in unaquaque cohobatione, atque sic tandem fal alcali cum spiritu urinæ transit in recipiens in forma butyri antimonii.

Nullius est saporis, lucet tamen scintillatione continua instar luminis stellaris, & est ultra modum volatile ac fortis odoris, quasi sulphuris accensi; ideo conservari debet in vase vitreo clauso, infusa aqua communi desuper, atque tum radios emittit per aquam, & fulgura, quæ totum occupant vitrum quando agitur; si enim sit extra aquam in aere libero, evanescit, tantæ extensionis est capax ut lentis magnitudine sufficiat ad illinendum totum corpus, quod luminosum apparebit, quasi igne & flammis circumdatum, absque minima erosione; nihil aliud accendere potest quantum hucusque scitur nisi pulverem pyrium.

Phosphorus Metallorum.

TAKE *Lapis Smaragdi Mineralis* (such as is found in the Mines of *Saxony*); beat it into a very fine Powder:

IF you strew this, very fine, on a Plate, of any Metal, and in any Figure, and set the Plate on hot Coals; in a short Time you will perceive, in the Dark, a Light to shine; which will (saith my Author) last as long as you continue the hot Coals: And if you beat out the Fire, it may do again, for once or twice; but then the Vertue will fade.

Phosphoros Elementaris, *by Dr. Brandt of*
Hamburgh.

TAKE a Quantity of Urine (not less for one Experiment than 50 or 60 Pails full); let it lie steeping in one or more Tubs, or an Hoghead of oaken Wood, till it putrify and breed Worms, as it will do in 14 or 15 Days. Then, in a large Kettle, set some of it to boil on a strong Fire, and, as it consumes and evaporates, pour in more, and so on, till, at last, the whole Quantity be reduced to a Paste, or rather a hard Coal, or Crust, which it will resemble; and this may be done in two or three Days, if the Fire be well tended, but else it may be doing a Fortnight or more. Then take the said Paste, or Coal; powder it, and add thereto some fair Water, about 15 Fingers high, or four Times as high as the Powder, and boil them together for $\frac{1}{4}$ of an Hour. Then strain the Liquor and all through a woollen Cloth; that which sticks behind, may be thrown away, but the Liquor that passes, must be taken and boil'd till it come to a Salt, which it will be in a few Hours. Then take off the *Caput Mortuum* (which you have at any Apothecary's, being the Remainder of *Aqua Fortis* from Vitriol and Salt of Niter) and add a Pound thereof to half a Pound of the said Salt,
both

both of them being first finely pulverized. And then for 24 Hours steep'd in the most rectify'd Spirit of Wine, two or three Fingers high, so as it will become a Kind of Pap.

T H E N evaporate all in warm Sand, and there will remain a red, or reddish, Salt. Take this Salt, put it into a Retort, and, for the first Hour, begin with a small Fire ; more the next, a greater the 3d, and more the 4th ; and then continue it, as high as you can, for 24 Hours. Sometimes, by the Force of the Fire, 12 Hours proves enough ; for when you see the Recipient white, and shining with the Fire, and that there are no more Flashes, or, as it were, Blasts of Wind, coming from Time to Time from the Retort, then the Work is finished. And you may, with a Feather, gather the Fire together, or scrape it off with a Knife, where it sticks.

T H E Fire is best preserved in a Vessel of Lead, closed up from the Air : But to be seen, 'tis also put into a Glass, in Water, where it will shine in the Dark, but must be close stopp'd. Some of this Fire, placed in the Beams of the Sun, will kindle Gun-powder : I saw some of it, press'd with a Quill that was cut, and it fired Gun-powder about it. Mr. *Concle* writ also with it on Paper, and the Letters all shined in the Dark, and when they decayed, the rubbing the Paper, with the Fingers, revived it again, and this after two Days.

M Y Author says, he had once wrapp'd up a Knob in Wax, at *Hanover*, and it being in his Pocket, and he busy near the Fire, the very Heat set it in Flame, and burn'd all his Cloaths, and his Fingers also ; for though he rubbed them in the Dirt, nothing would quench it, unless he had had Water ; he was ill for 15 Days, and the Skin came off. You may write herewith on Paper, a Wall, or any Wood, &c.

N. B. THAT to make this Fire join in Knobs, you must, after gathering it from the Recipient, put it into a Glafs (like a Urinal) and putting it *in Balneo*, or warm Sand, there will evaporate some Humidity that lies within it, and thereupon it will stick the better together.

N. B. THE Retort must be very well luted, to resist the continued Heat: Take therefore, to 50 Pound of fat Clay, as much white Tartar, as much fine Sand, wash'd and dry'd, and 1 Pound of Cow's Hair; all these, mix'd and beat together, will close it Hermetically.

N. B. THAT, when the Operation is done, you must take off the Retort, and stop it with some of the same Clay, well warmed, immediately, that the Air enter not; for in Case you should leave all to cool, with the Retort on, the Fire, desired, would retire thereinto.

N. B. THAT some do give a little Vent to the Retort, or Recipient, because of the violent Heat in the Operation, but he never does it.

Phosphoros Baldwini.

R Ec. Spiritus nitri optimi, qui quodammodo ad flavedinem inclinat, q. pl. hunc mitiga cum dimidia parte *Aq. Fortis*; postmodum solve in hoc cretam optimam albissimam & siccissimam, & quidem tantum quantum hic liquor admittit: unde tandem acquirit odorem suavem, fere instar olei amygdalarum. Hoc solutum filtra, filtratum infunde in cucurbitam, & igne lenissimo abstrahere phlegma: fortiore dein urge, ut bene fluat, & quasi ebulliat: hoc facto, sine ut ignis extinguatur, exime nitri distillati caput mortuum & in aere solve; solutum in loco calido exsicca, & habebis p. se. splendens

dens quidpiam. Vel si vis ut splendeat in quodam fracto fictili (\therefore psrrbus \therefore) tunc accipe Verdig. & [hanc materiam] pone super frustum fictilis cujusdam in fornacem probatoriam, aut sub veteri olla. Da vehementissimum ignem, ut bene fluat; exime & verte seu move frustum in omnes partes, ut liquor fluens ubivis fictili adhæreat. Reponas in loco quodam, ubi ab aere sit immune, & habebis quod quæris.

I Shall here insert the preceding Recipe, as I met with it in English, by reason it contains several remarkable Things that are not in the Latin.

W. DERHAM.

Baldwyn's Modus præparandi Phosphori Hermetici.

TAKE *Spiritus Nitri*, about a Pound; put it into a Glass Body, and put into the same, as much as you can take up, with the Point of a Knife, of the common powder'd *Creta Alba*, then it will begin to ferment, or hiss; and when it has done Hissing, put some more of the same powder'd *Creta*, and continue to do so, till it be satiated; hereupon the said fermented Spirit, by reason of precipitating many *Fæces*, is to be filtrated *per Chartam Bibulam*, and afterward distilled off, by a Retort in Sand, untill it coagulate itself, *in Fundo*, into a white Salt: Which must be kept carefully from the Air, because otherwise it very easily runs into an Oil. Afterwards, when you would prepare it for the *Phosphorus*, there must be a Proof-Furnace, with a Muffel, well heated, till it be red-hot.

N. B. In the Government of the Fire lies the main Business; for if the Proof-Furnace be not

hot enough, then the Salt flows, or ascends, not orderly high enough; but if it be too hot, then the Sulphurous Niter evaporates; then there is put, of the aforefaid Salt, two Lote (an Ounce) in Proportion of the Space, into a Proof-Pot, (or Crucible, wherein they make Ore to boil) and set it again into the Proof-Furnace, under the Muffel, and then the Salt doth presently run into a Water, but soon hardens again, and then runs and mounts up again, that the whole Proof-Pot, in the mean Time, is cover'd; but soon after that, the Gold will more and more consume it self, that only in the Midst of the Crucible, the Powder 1, 7, 5, 19, 2, remains only with a little Moisture, wherein it must be well observ'd, that as soon as the Border of the Crucible is dry, though in the Middle there appear some Moisture, the same Crucible be suddenly taken off, and let cool of itself. If the Work succeeds well, then the Brim will be yellow altogether; which (First,) *Ex Aere* attracts the Fire, and in the Dark casts it off again. (2dly,) In the Night, when you hold it to your warm Body, in your Bed, it shines. And, (3dly,) When in the Evening you strike it with a Brush, or Feather, or small Piece of Wood, somewhat hard, it causes very bright, fiery Sparks. But the same Crucibles will not last long, because they attract so much of Air and Moisture, *Magnetice*, and moulder at last: Therefore, at the Beginning, I set it in a Pewter Box, covered with Glass, half the Body cut off from the Neck, and well luted, the same to make it keep the longer. But if you would have the *Phosphorus* in the Figure of a Star, then you must not only have the *Sal*, but many Crucibles; and when the same are prepared, as formerly, then only that, which is yellow and shining at Top, must be scraped off, upon white Paper,

Paper, till there be a pretty Quantity of the said Powder together, according to the Proportion of the Star intended: Hereupon one takes a small round Looking-Glass, whose Foil is not made of *Mercury*, but *Lead*, in which cut therein a Star; then, after the Powder is mixed with a little white Wax, melted and heated in a Silver Spoon, over the Coal Fire, well stirred, with a little Stick; then this Mixture, while yet melted, is poured on the back Side, or hollow Side of the Glass, (which also must be warm'd, lest it break). Now as soon as the *Phosphorus* is prepared, in Manner aforesaid, then it is to be put into a Pewter, or Silver Box, and the Edges of the Looking-Glass are well secured with Sealing-Wax dropp'd upon it, round about; and then the Wax must be made handsome, and smoothed, and covered with Paper, either blue or gilded.

De Germinatione Metall.

R E Q U I R I T U R ad germinationem metalli. 1. Terra apta, in qua fiat germinatio, quæ est regulus stellatus, vel etiam regulus simplex. 2. Color. 3. Humor, quo fit imbibitio.

R E G U L U S conficitur ex antimonio, nitro, sale communi & tartaro, æqualibus partibus, toties repetita fusione, donec regulus fiat albissimus, instar lunæ. Regulo sive terra philosophica habita, itur postmodum ad praxin sequenti modo. 1. Fiat amalgama terræ philosophicæ & mercurii, qui est humor, ad germinationem metallicam pertinens; in hac unione proportio talis est observanda. Si vis germinationem *solis*, recipe *solis* 3j, terræ philosophicæ 3x, fundantur simul & uniantur. Eadem dosis est *martis* germinandi. Argenti vero dosis

3j, terræ philosophicæ 3v, eandemque dosin obtinent *saturnus, jupiter & venus*.

HAC unione facta sequitur cum ea unio mercurialis hoc modo. *Rec.* Frustulum terræ philosophicæ, idque crassiuscule contunde, nunquam enim uniretur, si redigeretur in pulvèrem. Huic terræ gressu modo sic contusæ adjicias tantundem mercurii, misceasq; optime in mortario æneo tamdiu, donec totum sit unitum. Dehinc accipe vas vitreum oblongi colli, sed ventre instar pilæ rotundo, in sui parte superiore recurvum, non autem in sui collo dilatatum, quia ad germinationem requiritur circulatio, non autem sublimatio. In hac pila tumulabis materialia prædicta; inque pila aperta humidum mercurii excrementitium sive superfluum evaporabis. Facta evaporatione, pila hermetice sigilletur; dein ponatur in furno clauso, hypocaufti calore instructo, inque eo per mensem relinquatur: tum videbis metallum ramusculos sursum emittere jucundos, cavitatem pilæ occupantes. Germinatione facta frangatur vas, & ramusculi e sua terra eradicentur, inque ignem denuo exponantur, ac denique cum aquis cordialibus abluantur, siccantur, & in vitreo vase ad usum serventur.

PRO regulo etiam sumere potes Electrum, quod fit hoc modo. *Rec.* Solis 3ij, lunæ 3iiij, martis 3ij, veneris 3iiij, jovis 3viiij, saturni 3xvj. Primo fundatur h , 2 4 , 3 9 , 4 D , 5 C . Sed adverte, chalybem limatum prius esse debere, & mixtum cum mercurio sublimato & nitro, alias cum reliquis non uniretur: tandem & sol funditur. Atque hoc ex omnibus mixtum conficitur electrum.

HIC pulvis blande admodum purgatus, obstructions contumaces domat, & viscera roborat, ideoque in affixo hypochondriaco, hydrope & similibus morbis prodest. Dosis est a gr.2. ad 4. in syrupo, conserva, & aqua appropriata. Eadem est dosis electri.

Toge-

Together with the Preparation of Baldwyn's Phosphoros, I find that of making what we call Tin, or Latten-Plates; which probably was communicated by Baldwyn.

W. DERHAM.

The Way of making Latten-Plates.

TAKE tough Iron, that will bear the Hammer well; and having hammer'd it thin, ply it into the Size you would have cut your *Latten*; then put this Iron into a Mixture of Clay and Water, of a pretty Consistence, and let it stand two or three Days; then take it out and hammer it again, as thin as you will have it for your Purpose; the aforesaid Mixture, that sticketh between the Iron Leaves, keeping them from being beaten into one another; then cut those iron Leaves afunder, with strong Sheers, and throw by the Cuttings, as useles; then put these Iron Leaves into a Mixture of Rye-Meal, coarsly ground, and common Water, pretty thick, the Clay being first rubbed off, and let them steep therein four Days; then take them out, and dip them into a Kettle of melted Tin, but draw them quickly out again; then put these tinn'd Leaves between the Wires of an Iron Bar, made with Wires fit for this Purpose, that the superfluous Tin may run off, into a Pan to receive it underneath. And because the Tin will grow cold at the lower End, and so thicker, in an Iron, an Inch deep, filled with melted Tin, dip the thicker Ends of your Leaves, one after another, and the hot Tin will melt down the Excess of Thickness, but you must take them out again quickly; and, with a woollen Cloath, between
your

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your two Fingers, wipe them off beneath ; which you will see to have been done, in all *Latten-Plates*, by certain Strokes appearing at one End. These are made shining, by rubbing them all over with woollen Rags.

In Dr. Hook's Diary, Dec. 26. 1673. I find this Remark, viz. Mr. Yarrington, who had seen the Latten-making Works, near Leipfick, said, many Plates are beat under the Hammer, at once, like Leaf-Gold, or Tin-Foil. The great Difficulty is, how to turn them under the Hammer quick enough.

W. DERHAM.

The Genuine Recept for making Orvietano.

R Ec. Fol. Dictamni cretenfis recentior. herb. Cardui benedict. Pulegii regalis Hyperici & Scordii ; radi. Aristolo. long. & rotund. Biftortæ, Tormentillæ, Gentianæ. Imperator. Carlin. Scorzonner. Afclepiad, contrayervæ Valerianæ, Angelicæ veræ, petasitidis, bacc. Lauri & feminis Petroselini & Dauci cretenfis ana partes æquales ; & unicuique lib. pulveris, adde theriacæ Andro veteris & mithridati veri an ʒij Postea reducatur in electuarium molle cum Extracto Juniperi baccar. vino albo parat. & in mellis cocti consistentiam reducatur, redacti addendo sub finem pro quaq; libræ electuarii semidrach. vitrioli cyprei in pulv. tenuiff. triti ; & carnis viperarum exsiccata, pro quaque libra, ʒj. Hoc electuarium quotidie bis movere debes, per integrum mensem ; deinde ad usum repone.

This I translate out of the Paris Mountebank's Paper, in French more at large.

N. LE FEBURE.

THIS

THIS is the Secret of *Orvietano*, and it is made by the Heirs of *Heronimo Ferranti*, who was the first Inventor of this rare *Recipe*. It is now come, by the Marriage of a Daughter, to the *Contugi*, the famous Mountebank, at present, at *Paris*; but it was given by *John Vitrario*, the Successor of *Ferranti*, to the Great Duke of *Tuscany*, for a Sum of Money; by whom it was sent, fairly written, and put into a great Box, unto the late Monsieur *de Guise*; and by him, as a great Curiosity, to the Duke of *Bouillon*; from whose Physician, Monsieur *la Febure*, my good Friend and Correspondent, that had often made Trial thereof, with great Success, I receiv'd it as a choice Secret, at my last being in *France*, 1652.

J. EVELYN.

The Virtues.

TO expel Poison: Take the Quantity of a Bean, mix'd with Oil Olive, Butter-Milk, or Broth hot; drink three or four Times, till all the Venom be expell'd by Vomit.

After which, let the Patient sup up a good Draught of Broth, very fat, with an Ounce of *Mel Rosarum*. If any be bitten with a mad Dog, or Serpent, take of *Orvietan*, as before, in Wine; then scarify the Bite, and draw Blood, *per cucurbitam*, to which apply *Orvietan*, keeping the Patient waking 12 Hours.

IN Agues, Fevers, Exanthems, and all Contagions, *Rec. Orvietan* in some Borage, or Scabious Water, the Weight of a Crown in Gold; but to a Child, in a Fever, caused by the Small Pox, not exceeding the Weight of a Bean, taken in White-Wine; the Child well cover'd.

I r

IT preserves from the Pestilence, taking the Quantity of a small Button. Taken also in Wine, Broth, or a Pill, in the Morning, it corroborates the natural Heat, aids Digestion, hinders Pains in the Stomach, Difficulty of Respiration, stinking Breath; cures cataractical Vapours and Distillations, the Cholick, windy and rheumatical Spleen, *Dolores Matricis* (except in *Gravidis*) kills Worms in Children.

FOR Cattle that have Swelling, and Pains in the Belly, 'tis very excellent, giving them a Drench in half a Pint of White-Wine, warm. *Orvietan* will keep 25 Years, and more, in a cold Place; or it may be reserved in Powder, and put into a Consistency, with *Mel Rosarum* at Pleasure.

Ink for the Rolling-Press.

THE best Black is the *German Black*, and comes from *Frankfort*; it looks like Velvet, and easily crumbles betwixt the Fingers, like Chalk. Of this there is a Counterfeit, made of Lees of Wine burn'd, which is full of Gravel, and very pernicious to Plates.

TAKE excellent Nutt-Oil, and put a good Quantity thereof into a large Iron Pot (which has a Cover exactly fitted to it) so as to fill it within three or four Fingers Breadth of the Top; cover it, and hang the Pot, or set it on a Trivet, over a good Fire, till it has boil'd; but have a Care that at first it boil not over, nor yet when it boils; for 'twould indanger the Houle. Therefore, diligently observe it, and frequently stir it with an Iron *Spatula*. Then being very hot, kindle it with a Piece of Paper, lighted. Having thus taken Fire, remove it from the Trivet, into the Chimney-

Chimney-Corner, continually stirring it, whilst it burns ; which ought to be for the Space of half an Hour, at least. When you would extinguish the Flame, clap the Cover on it, and if it does exactly cover it, you will presently extinguish it, otherwise you must put a Linnen Cloth likewise, that no Air may enter ; then let it cool a little, and pour it into a Vessel, wherein you will preserve it. This they call the weaker Oil, in Comparifon of the following, which they call the strong Oil.

AND this is made by putting fresh and crude Oil into the same Pot, and ordering it just as you did the weak, only suffering it to burn a great deal longer, and stirring it often, till it become thick and glewy ; so that dropping a little of it upon a cold Plate, it may, in a little Time, be drawn out into Threads, like a Syrup. Some Workmen put into it an Onion, or a Crust of Bread whilst it boils, and hold that it helps to cleanse the Greasiness of it.

IF it hap that the Fire be too violently taken, cast in a Quarter of a Pint of crude Oil ; but to prevent all Accidents, boil it in an open Court.

THIS done, grind, of the aforesaid *German* Black, on a very clean Stone and Mullar, about half a Pound, pouring on it, at several Times, more or less, as you see Occasion, about half a Pint of the weaker Oil (for some Blacking will take up more than other some) but be extreamly careful, not to pour on too much. After you have thus grosly ground it over, re-grind it over again, by a little and a little at a Time, till it become very fine ; then put it altogether on the Stone, and add to it about the Quantity of a small Hen Egg, of your thicker, or strong Oil, blend them well together, and cover them very close, in a well-glaz'd earthen Pot, to preserve it well from Dust, for your Use.

N. B. FOR Plates that are worn, or not deeply graven, you need not put so much strong Oil into the Ink : Likewise your Black must be good, and well ground, else it will give no good Impression, and will quickly wear the Plate. And if the Oils be not burn'd into a due Consistency, the Black will be left behind, in the Hatches of the Plate, and the Impression will be pale, and nothing worth.

J. EVELYN.

*Divers curious Recepts, collected by
Dr. HOOK.*

To give Iron the Colour of Copper.

TAKE one Ounce of Copper Plates, cleansed in the Fire ; three Ounces of *Aqua Fortis* ; dissolve the Copper, and when 'tis cold, use it by washing your Iron with it, by the Help of a Feather ; 'tis presently cleansed and smooth, and will be of a Copper Colour ; by much using or rubbing, 'twill wear off, but may be renew'd the same Way.

A Way of gilding with Gold upon Silver.

BEAT a Ducket thin, and dissolve it in two Ounces of *Aqua Regia* ; dip clean Rags in it, and let them dry ; burn the Rags, and, with the Tinder thereof, rub the Silver with a little Spittle ; be sure first, that the Silver be cleansed from Grease.

To make Copper into a Metal like Gold.

Rec. Distill'd *Verdigrease* four Ounces; *Tutia Alexandrina preparata*, two Ounces; *Salt Petre*, one Ounce; *Borax*, half an Ounce; mix all together with Oil, till they be as thick as Pap; then melt it in a Crucible, and pour it into a Fire-Shovel, first well warmed.

Memorandum. My Author says, That this will not only appear, but work like coarse Gold; that he sold it as dear as Silver; that the King of *Poland* had a Service of it, only mixing 15 Ounces of Gold, to 100 Ounces of this Metal.

To whiten Copper throughout.

TAKE thin Plates of Copper, as thin as a Knife, heat them 6 or 7 Times, and quench them in Water; then melt them, and to each Pound add 4 Ounces of *Salt Petre*, and 4 Ounces of *Arsenick*, well powder'd and mix'd, and first melted apart in another Crucible, by gentle Degrees; then take them out, and powder them; then take *Venetian Borax*, and white *Tartar*, of each an Ounce and half; then melt these, with the former Powder, in a Crucible, and pour them out into some iron Receiver; it will appear as clear as Crystal, and is called *Crystallinum fixum arsenicum*. Of this clear Matter, broken into little Pieces, throw into the melted Copper (by small Pieces at a Time, staying 5 or 6 Minutes between each Injection) 4 Ounces; when all is thrown in, increase the Fire, till all be well melted together for a Quarter of an Hour; then pour it out into an Ingot.

N. B. To

N. B. To make this Matter the more malleable, add a Quarter of a Pound of Silver first melted, and the former Metal poured into it, and then proceed *ut supra*, where indeed the Cryſtalline Powder ought first to be prepar'd.

N. B. Also that this Process is not to be done in a close Room, by reason of the poisonous Steams of the *Arsenick*.

To make transparent Silver.

Rec. Refin'd Silver, one Ounce; dissolve it in two Ounces of *Aqua Fortis*, precipitate it with a Pugil of Salt, then strain it through a Paper, and the Remainder melt in a Crucible, for about half an Hour, and pour it out, and 'twill be transparent.

Dissolutions. Gold is dissolved in *Aqua Regis*; 'tis precipitated with Silver, or sooner with Quick-silver; all other Metals are dissolved by *Aqua Fortis*; Silver then is precipitated with Copper; Copper by Iron; Iron by Lead or Tin; Tin by Lead or common Salt. *Aqua Fortis* is made by *Niter*, *Vitriol* and Sand. *Aqua Regis* is made of *Aqua Fortis* and *Sal Armoniac*. *Sal Armoniac* is made of Camel's Urine, press'd out of the Dung; or out of Horse Urine, press'd out of the Dung. Volatile Salt is extracted out of Urine, Blood, Soap, and Hartshorn.

N. B. After the Dissolution, there remains a black Sand, the Author says 'tis Gold; it may be edulcorated by Water. The first Water of the Dissolution dyed the Hair of my Horse of a Purple Colour, and Yellow and Black; if there had been more Silver, or the *Aqua Fortis* stronger, it had been quite Black; it is apt to burn the Skin, but then did not. *The*

The Roman Pomade.

T A K E Apples of a good Smell : Pare and core them, and cut each into six Pieces; then take Hog's Grease of the Bowels, which has not been melted, wash it in Orange and Citron Flower Water *aa* ; then add Cloves, Cinnamon, Galinga, *Ligni Santali aa ʒj. Ligni Rosarum, Sassafras, Vio-larum Radicum, Benjamin, Storax Calamita aa ʒj.* chop all into small Pieces, and mingle them with the Apples and the Lard; pour over all, Rose-water a Finger high, and let it boil on a gentle Fire, till all the Moisture be gone ; then strain it whilst hot through a Cloath, and afterwards mix therewith six Ounces of white Wax melted, and well stirred together ; this must be done in a new earthen Pot, and while you are stirring it, yet hot, pour in one after another of Oil of Cinnamon, of Citrons, Oranges, Roses, and Jasmine, *aa* six Drops.

To perfume Clothes.

T A K E dry'd Red Roses, and, to encrease their Smell, pour on them fresh Rose-Water, and still drying between in the Shade ; then take Cloves, Cinnamon, Spikenard Seed, Storax, Calamita, Benjamin, Violet Roots, Nutmegs, *aa ʒij.* to a Pound of Roses; beat them all into small Pieces, and mix them with the Roses, and put them into perfuming Bags.

Cypress Powder for the Hair.

T A K E Red Rose Leaves in Powder, wet them as before, add Musk 12 Grains, Civet 10 Grains, Ambergrease 8 Grains, Cinnamon, and Storax Calamita

lamita aa ʒj. Cloves, ʒij. of the Moss of an Oak, one Pound, well dry'd, and powdered, and six Times washed with Rose-water as before; then add three Ounces of Violet Roots in Powder, mix all together, and pass them through a Searce, and use it.

To marble a Globe Glass.

GRIND well on a Stone, *Minium* for Red, *Turmeric*, or rather *Cerussa Citrina*, for Yellow, *Smalt* for Blue, *Verdigrease* for Green, *Ceruse*, or Chalk, for White. Work each in Oil separate, and with a Hog's-Hair Pencil, single or mix'd as you think fit, scatter the same into the Glass, and roll it, or dispose the Colours, as you like. Then last of all, sling a little Mead amongst them, which covers all.

FOR the magick Lanthorn, paint the Glasses with transparent Colours, tempered with Oil of Spike.

To gild Carps, Crawfish, &c.

WARM an earthen Pot, till it receive as much white Pitch as will stick round it within; then strew finely powder'd Amber over the white Pitch; when 'tis growing cold, pour into it *Oleum Lini*, three Pound; *Oleum Terebinth*, one Pound well mixed together. Close up all, and boil them an Hour on a gentle Fire: This is a Varnish. Grind some of this on a Painter's Stone, throwing to it fine Powder of Pumice-Stone, till it be as thick as ordinary Paint; then take a live Carp, or Craw-fish, out of the Water, and dry it well with a Linnen Cloath; then daub it over with this Paint, it will presently dry, before which spread your Leaf Gold, and gently press it with a soft dry Cloath, and then you may let it go into the Water. For the more this Varnish is in the Water, the harder it dries and grows, and does the Fish no Hurt.

Many

Many fuch gilded Fish are in the Prince of *Silacaw*'s Garden in *Bohemia*, 18 Leagues from *Prague*; he has 200 thus gilded.

The four Elements put in a Cylindrical Glafs with a Foot.

Spirit of Wine, Oil of Tartar *per deliquium*, Spirit of Turpentine and Antimony grossly beaten: Take of each an equal Quantity, and no two of these will mix.

To Foil Glafs.

TAKE a Sheet of *Muscovy*, or other Glafs, as big as convenient, and as thin as possibly it can be made: Get also some *Tin-Foil*, and laying it upon a Sheet of very fine Paper, most curiously fleeked, that also being laid upon a Plain that is exactly plain and smooth; then with a clean Cloath, or Piece of Leather, make your *Tin-Foil* clean, and to lie very smooth, that there may be no Wrinkles in it; this done, put on a little Quicksilver, and rub it upon it, with a Cloath, or Piece of Leather, so long, until it be all Black therewith; then with a Cloth rub that also clean off; this done, put on as much Quicksilver as will cover the *Tin-Foil* all over; then upon that, as close to it as possibly you can, slide on the *Muscovy* Glafs, shoving off as much of the *Mercury* as you can: This done, clap down the other half Sheet upon it, which must be exceeding fine, and most exactly polish'd; upon this lay a Plane, that is very smooth, lest otherwise it cause Wrinkles; then press it, so as it may be plain, for 12 Hours; then take it out, and let it stand, or hang upright, so as it may send away the loose Quicksilver; afterwards order it as you please.

After this Manner all Sorts of Glafs are foiled.

A Discourse of Mr. John Cafwell, late Savilian Professor of Oxford, concerning the going back of the Shadow on a Sun-Dial. Read at a Meeting of the Philosophical Society, at Oxford, June the 22d. 1686.

UPON reading the Minutes of the *Dublin Society*, of *Mar. 1.* that Mr. *Tolet* had discours'd of the Shadows going twice Forward, and twice Backward, in the same Day, in a Place of the *Torrid Zone* : It was desired by our Members, then present, that I would take it upon me, to explain, at our next Meeting, how this might be. In answer thereto, I have shewn, in the following Discourse, how the Shadow of a Stile, perpendicular to the Horizon, does go Backward in the *Torrid Zone*, but not of those Stiles that point to the Pole, as it is in Common Dials ; also how, by directing the Stile betwixt the Tropicks, the Shadow may go back on Horizontal Dials in all Latitudes, and in all other Plains, if the Sun does not leave them too soon ; together with the Calculation of the Time, and Quantity, of the Shadow's Regression, according to any given Situation of the Stile and Plane.

By a Stile, I understand a streight Line insisting on a Plane, and casting a Shadow thereon.

A perpendicular Stile, I call that which is perpendicular to the Plane ; an oblique Stile, which is oblique.

WHEN I mention a Stile, without distinguishing perpendicular or oblique, it is to be understood of either.

By the Meridian of the Plane, I mean a great Circle drawn thro' the Pole of the World, and Poles of the Plane.

SUPPOSE a Circle describ'd on the Plane from the Foot of the Stile (*i. e.* the Point where it cuts the Plane), as a Center: The Way of the Shadow I reckon on the Circumference of this Circle: And Note, when the Shadow goes one Way round this Circle, without any Change, during one Day, I say, 'tis wholly Direct: But if it changes its Course, the first Motion it takes before the Change, I call Regressi^on, or Backward; and the second Motion I call Progressi^on, or Forward; for 'tis the first Motion that I conceive contrary to what is usual, and which I therefore call Retrograde, rather than Direct. In this Sense the Shadow may be twice Retrograde, and once Direct in the same Day, as shall be demonstrated.

Prop. I. THE Shadow of the Stile, on the Plane, is the common Section of the Plane, with a great Circle drawn thro' the Sun and Stile.

Prop. II. THE Semidiameter of the Earth is insensible, in respect of the vast Distance of the Sun from us; therefore the Foot of the Stile, which is really at the Surface of the Earth, may be suppos'd the Center of the Earth; and consequently the Plane of the Dial may be taken for the Plane of a great Circle of the Sphere, parallel thereto.

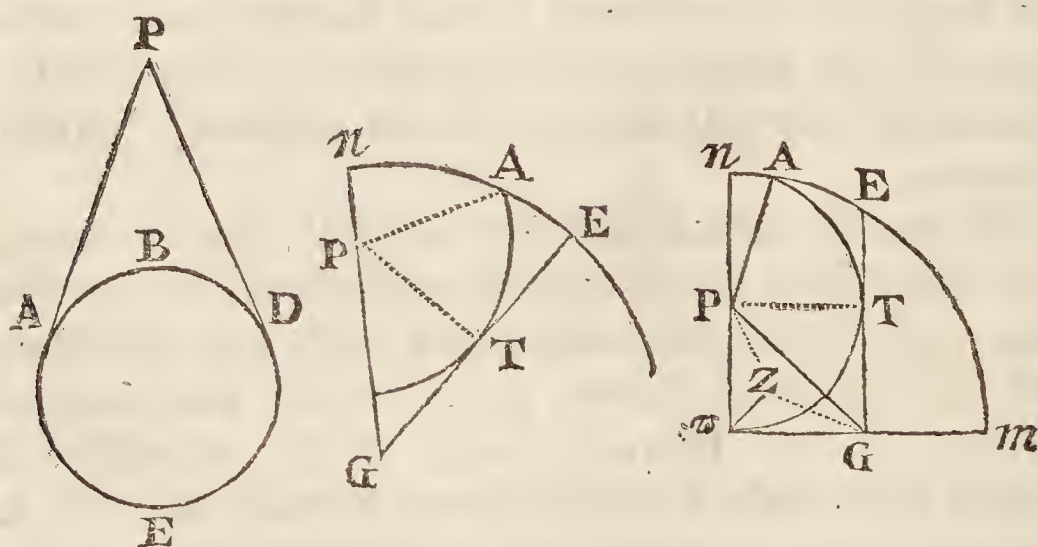
Prop. III. THE Shadow cannot go Backward (in the same Day, and so understand in the following), if the Stile continu'd does cut the Plane of the Diurnal Circle, (*i. e.* which the Sun describes in the Heavens, and which is otherwise call'd the Sun's Parallel, or a Parallel to the Æquator) in, or within its Perimeter, because the Shadow is always in a Plane, drawn thro' the Sun and Stile, if the Point of Section is in, or within the Diurnal Circle's Perimeter, because the Sun goes constantly Forward, so will the Shadow.

Cor. I. IF the Stile be the Axis of the World, the Shadow cannot go back: For the Axis cuts all the Parallels of the Æquator in their Centers; therefore in no Latitude can a Plane and Stile be plac'd, that the Shadow, which shews the Hour, with its whole Length, may go backward; only a Stile may be so plac'd, that its Shadow may go backward, and a Nodus therein shew the Hour.

Cor. II. THE Shadow cannot be made to go backward, on either of the Æquinoctial Days, for then the Sun's Diurnal Circle, being a great Circle, is cut by the Stile, thro' the Center.

Cor. III. THE Shadow cannot go back, if the Stile point without the Tropicks; for then it will cut the Planes of all the Diurnal Circles within their Perimeters.

Prop. IV. IF the Stile cut the Plane of the Diurnal Circle, without its Perimeter, the Shadow will go forward and backward in 24 Hours; provided the Sun shine, a sufficient Part of the 24 Hours, on the Plane. For suppose P, the Point



where the Stile cuts the Plane of the Diurnal Circle; from P draw two Lines touching this Circle in A D; 'tis evident the Shadow goes one Way, while

while the Sun passes the Arc ABD ; but the contrary Way, while it passes DEA .

Cor. IF the Arc which the Sun describes, while it shines on the Plane, be Part of ABD , and Part of DEA , the Shadow will go forward and backward.

Prop. V. IF from that Point in the Surface of the Globe, which represents the Top of the Stile, two great Circles be drawn, touching the Sun's Parallel; and if the Dial-Plane cut off an Arc of the Parallel, of which all, or part, is visible, (*i. e.* above the Horizon); if also either of the Points of Contact be included within the Extrems of this visible Arc; then will the Shadow go backward, till the Sun come to the Point of Contact; after which it will go forward, till it come to the other Point of Contact; and then the Shadow will go backward again.

Cor. I. The Shadow, in one Day's Time, in any Latitude, however the Plane and Stile be plac'd, can change its Course but twice, (*i. e.*) it may be Retrograde, Direct and Retrograde, but not a second Time Direct.

Cor. II. 'TIS evident, there are in any Latitude innumerable Diversities of Inclinations of the Dial-Plane to the Horizon, and of the Stile to the Plane; also of Declinations of both Stile and Plane from the Meridian, whereby the Shadow may be made to go backward.

Prop. VI. THE Shadow cannot go back, while the Sun is nearer the *Æquator*, than the Top of the Stile to the *Æquator*. And this holds good, whether the Sun and Top of the Stile be on the same, or different Sides of the *Æquator*. For the Planes of all Diurnal Circles, which are nearer to

the *Æquator*, than the Top of the Stile, are cut by the Stile within their Perimeters, because the Stile passes thro' the Center of the Sphere.

Cor. THE nearer the Stile points to the *Æquator*, the more Days in the Year will the Shadow go back ; but then, in any one Day, it will go back the less, *cæteris paribus*.

Prop. VII. THE Shadow of a Stile pointing to any one Place of the Heavens, betwixt the *Æquator* and either *Tropick*, will go back all those Days, wherein the Sun's Parallel is farther from the *Æquator*, than the Top of the Stile is from the *Æquator*. And this holds, whether the Sun, and the Top of the Stile, be on the same, or different Sides of the *Æquator*: But with this *Proviso*, in both Cases, that the Point of Contact lie in the visible Diurnal Arc above the Plane. For Example, In our Latitude of *Oxford*, if a Stile Point as far North, as is the Beginning of the Sign *Taurus* ; then the Shadow will be Retrograde every Day, while the Sun is passing thro' *Taurus*, *Gemini*, *Cancer*, *Leo*. But while the Sun passes through *Virgo* and *Libra*, the Shadow is only Direct, or Forward; then in passing thro' *Scorpio*, *Sagittarius*, *Capricorn* and *Aquarius*, 'tis Retrograde again: But with this Difference, that if the Shadow is twice Retrograde, any Day, while the Sun runs a Northern Parallel, then it will not be Retrograde once, in the Day of the Opposite Southern Parallel. But if the Shadow is once Retrograde, in a Day of the Northern Parallel, then it will also be once Retrograde, in the Day of the Opposite Parallel.

Prop. VIII. IF a perpendicular Stile point any where in the *Æquator*, the Shadow cannot go back any Day in the whole Year ; for all the
Points

Points of Contact lie in the Dial-Plane, to wit, there, where 'tis cross'd by the Diurnal Circles.

Prop. IX. IF an Oblique Stile point to the common Section of the *Æquator*, and the *Meridian* of the Plane; the Shadow will be Retrograde, during that half Year, while the Sun has Declination toward that Pole, which is elevated above the Plane. The other half Year, while the Sun is toward the depress'd Pole, the Shadow will be only Direct; for in the first half Year, the Points of Contact are above the Plane; in the Second, under.

Prop. X. IF an Oblique Stile point to any Place of the *Æquator* in the Heavens, except there, where the *Meridian* of the Plane crosses the *Æquator*; if withal, a great Circle describ'd from the Top of the Stile on the Globe, as a Pole, does cross the long Diurnal Arcs; (*i. e.*) of those Parallels which are toward that Pole of the World, which is elevated above the Plane; I say, if the said Circle crosses the long Arcs any where above the Plane, then will the Shadow be Retrograde, those Days, in which the Sun describes those Arcs, and on no other Days; for where the said Circle crosses the Arcs, are the Points of Contact. For Example; In all Direct South-reclining Planes, above which the North Pole is elevated, the Shadow goes back all our Summer half Year; but it is only Direct all the Winter half Year. But in other Planes, the too great Declination, or Inclination of the Plane, may cause the Points of Contact to fall under the Plane; so as only in a small Part of Summer, and in no Part of Winter, the Shadow may go back.

P R O B L E M.

Any Day being given, together with the Latitude of the Place, and the Situation of the Stile and Plane, to calculate the Time and Quantity of the Shadow's Regression on that Day.

SUPPOSE the Dial-Plane were *Horizontal*, and the Stile perpendicular thereto; because the Stile must point within the Tropicks, then this Case can happen only in the *Torrid Zone*, yet not in the *Æquator* (*by Prop. 8.*); nor can the Shadow go back, when the Sun is on one Side of the *Æquator*, and the Stile on the other, tho' at less Distance, because the Points of Contact are both under the *Horizon*; but then, to recompence this, the Shadow is twice Retrograde every Day; which to calculate, suppose Z the Zenith of the Place 10 Degrees North of the *Æquator*, which is now suppos'd the Pole of the Plane, and the Top of the Stile in the Heavens. Suppose the Sun in the Tropick of *Cancer*, and P the Pole of the World, T the Point of Contact (*i. e.*) where the great Circle, ZT, drawn from the Top of the Stile, touches the Tropick. Then in the right-angled Triangle ZPT, beside the Right-angle T, there is given PT, the Sun's Co-declination, and PZ the Colatitude of the Place; thence may be found the Angle ZPT, (as in *Fig. 3.*) the Sun's Distance from the Meridian, when the Shadow begins to change its Course; also the Angle PZT, from which, if you take the Sun's Azimuth from the North, at Rising, the Residue is the Quantity of the Shadow's Regression on the Circle of the Dial-Plane.

WHAT has been said of an *Horizontal* Plane, in the *Torrid Zone*, holds true for any Latitude out of the *Torrid Zone*, if you incline the former Plane,
till

till its perpendicular Stile point in the Meridian 10 Degrees above the *Æquator*, (*i. e.*) where it did in the Torrid Zone.

At 5 Hours 42 Minutes in the Morning, the Sun rises on this Plane ; at 7 Hours 36 Minutes, the Shadow changes its Course ; so the Duration of Regression is 1 Hour 54 Minutes ; the Quantity of Regression is 4 Degrees 26 Minutes. And so much, and at the same Distance from the Meridian, is the Retrogradation in the Afternoon. Thus it is at the Summer Solstice on this Plane, but the Regression will grow every Day less, as the Sun, in his Diurnal Course, comes nearer the Top of the Stile ; so as when the Sun runs over the Stile, then the Regression ceases.

E X A M P L E II.

SUPPOSE an *Horizontal Plane*, in the Latitude of *Oxford*, and the Sun in *Cancer*, the Stile pointing to G, (in *Fig. 2.*) 10 Degrees in the Meridian, above the *Æquator*: From G draw a great Circle, touching the Tropick of *Cancer* in T ; suppose this Circle, (continu'd) to cut the Horizon in E P, to be the Pole of the World, and that the Circle GP (continued) cuts the Horizon in *n*, and that the Tropick cuts the Horizon in A. In the right-angled Triangle GTP, GP and PT are known ; thence may be found the Angle TPG, the Sun's Distance from the Meridian, when the Shadow changes its Way, and the Angle PGT ; then in the right-angled Triangle, P *n* A, P *n* the Height of the Pole, and PA, the Sun's Co-declination, are given ; thence *n* A may be found, and in the right-angled Triangle G *n* E, G *n*, and the Angle E G *n* = PGT, are known, thence E *n* may be found ; but *n* E — *n* A = A E, which is the Quantity of the Shadow's Regression ; *viz.* The Shadow, in this Example, begins to change

change at 7 Hours 36 Minutes, in the Morning, and the Sun rises at 3 Hours 46 Minutes; therefore the Duration of Regression is 3 Hours 50 Minutes, and the Quantity of Regression 12 Degrees, 25 Minutes. And so much, and at the same Distance from the Meridian, 'tis again in the Afternoon.

E X A M P L E III.

A PLANE having any given Position, suppose 14 Degrees Declination, or Azimuth, Westward, and 71 Degrees Reclination, (*i.e.*) its Pole ω (in *Fig. 3.*) 19 Degrees from the Zenith Z, suppose of *Oxford*, which is Distant from P, the Pole of the World, 38 Degrees 14 Minutes; also a Stile being any Ways inclin'd to this Plane, yet so as to point betwixt the Tropicks; as suppose G the Top of the Stile, or Gnomon of the Globe, has 23 Degrees Azimuth, Eastward, and 42 Degrees Distance from the Zenith, on any Day propos'd; suppose at the Summer Solstice, when the Sun is farther from the \mathcal{A} equator, than G from the \mathcal{A} equator; to find when the Sun shall begin, and cease to shine on the Plane, and whether the Shadow shall at all be Retrograde in the Morning; and if so, how much, and when it shall be? (Like to which is the Calculation for the Evening).

FROM G draw a great Circle, touching the Tropick in T, and cutting the Dial-Circle in E; produce the great Circles ω P, ω G, till they cut the Dial-Circle in N, M. Suppose A the Point, where the Tropick cuts the Dial-Circle. First in the Triangle GZP, we have GZ, ZP and the Angle GZP, thence we may find the Angle G P Z, and Z G P, and PG; then in the right-angled Triangle P T G, we have P G, and P T, the Sun's Co-declination; thence we may have the Angle G P T, and the Angle PGT. Then the Angle ZPG + GPT = ZPT, the

the Distance of the Sun from the Meridian, when the Shadow ceases to be Retrograde, or first changes its Way. In the Triangle $\varpi Z G$, we have ϖZ , $Z G$, and the Angle $\varpi Z G$; thence we may find ϖG , the Angle $\varpi G Z$, and the Angle $G \varpi Z$. In the Triangle $P \varpi Z$, we have $Z P$, $Z \varpi$, and the Angle $\varpi Z P$; thence we may have $P \varpi$, the Angle $P \varpi Z$, and $\varpi P Z$; then the Quadrant $\varpi n - \varpi P = P n$; and the Quadrant $\varpi m - \varpi G = G m$; and the Angle $P \varpi Z + G \varpi Z = P \varpi G = n m$. Then the two Right-angles $- Z G \varpi - Z G P - P G T = E G m$. Then in the right-angled Triangle $E G m$, we have the Angle $E G m$, and $G m$; thence we may find $m E$. Then in the right-angled Triangle $P n A$, we know $P n$, and PA , the Sun's Co-declination; thence we may get NA , and the Angle $n P A$. Then the two right Angles, $- \varpi P Z - n P A - Z P A$, which is the Time before Noon, at which the Sun begins to shine on the Plane. Then $Z P A - Z P T = A P T$, is the Duration of the Shadow's Regression. If $Z P A$ is not bigger than $Z P T$, the the Shadow will not be Retrograde at all. Lastly, $m n - m E - n A = A E$, the Quantity of Regression.



Dr. HOOK's Way to find expeditiously, and certainly, the true Meridian; being somewhat different from the Method in his Posthumous Works, pag. 361.

PROVIDE a short Telescope of 1 Foot, or 18 Inches in Length, fitted with a Glass-Plate in the Focus; upon which proper Circles must be drawn, with the Point of a Diamond, for the Pole Star, and two other Stars not far distant from the Pole, which is supposed to be in the Center of this Glass. This Telescope must be fitted with two Plumb-Lines. Now by this Instrument, in any fair Night, tho' the Moon shine, it will be very easy to discover the proper Stars, thro' this Telescope, and to see that each of them be in its proper Circle, about the Polar Point: At which Time, the Axis of the Glass will be in the true Meridian, and, if fitted with the Quadrant, give the Altitude; and the Plumb-Lines being in the Meridian, there may be a Compass suspended by them, which will also shew the Variation easily and certainly. This Instrument is sufficiently intelligible, without any Scheme, which is therefore omitted.

ANOTHER Way is wholly new, and the Observations are made without an Instrument, and the Refractions of the Air do no ways influence either the Observations or Deductions. And that is, by observing, with Plumb-Lines, or other proper Instruments, either both at the same Time, if it may be, or one at one Time, and the other at another, with a true Account of the interposed Time, two Azimuth Lines, in each of which are found two considerable Stars. By the Help of which two Observations, and a true Projection of
the

the Sphere of the Stars, it will be easy and obvious, to any Navigator, to find the Latitude of the Place, the Meridian Line, and the Azimuths of the Stars.

These two Ways were proposed to the Royal Society, April 27. 1687.

W. DERHAM.

An Experiment shewn before the Royal Society, Jan. 26. 1689. by Dr. HOOK, of the Penetration of Dimensions in the Mixture of Vitriol and fair Water.

TH O' several Experiments have been made of the dissolving of several differing Sorts of Salts, successively in the same Water, after it has been satiated with one particular Salt, so as to dissolve, or take into it no more of that Salt; yet, in all these Experiments, there seems not to be any real Penetration of Dimensions; nor do I know of any other Experiment of the like Nature, that has been made by any Person. But, I conceive, it is very considerable in this, that Water, which has not (by the greatest Force which has been yet applied to it) been compress'd into lesser Dimensions, should yet admit a thicker, closer, and more ponderous Liquor to penetrate its Dimensions, without any Pressure or Force put to assist the Operation; and that two Liquors, so differing in other Qualities, should so readily, and harmoniously join and incorporate together. They differ first in Weight; for I find that the Oil of Vitriol, to the Water, is very near as 9 to 5; they differ in the Taste, the one being the greatest Acid, we know,

know, and the other perfectly insipid; the one very sluggish, and not rising in Fumes, but with violent Heat; the other evaporating very easily. It were too long to mention many other differing Qualifications and Effects; but this is worthy noting, that the Mixture of those two Liquors, both actually cold, produces a very strong actual Heat, and thereby causes a Rising of many small Bubbles out of the Water, and also an Expansion of both, for a Time, as plainly appears; for that as the Mixture grows cold, so it retires and shrinks into lesser Dimensions, as is visible to the Eye.

Now that I might give a more exact Account of the Success I had, and what was likely to be expected upon another Trial; here I tried the Experiment with all the Care I could. First then we weighed the Bolt-head, and found its Weight, empty, $2085\frac{1}{2}$ Grains. Then we filled it almost to the Top of the Neck, with common Water, and found its Weight to be 8775 Grains; from which, taking the Weight of the Bolt-head, we found the Water to weigh $6689\frac{1}{2}$ Grains; then making a Mark on the Neck, at the Top of the Water, we poured out so much as filled a small Glass Cane, and set a Mark at the Top of the remaining Water, and found it 18 Inches and a half below the first Mark; the Bolt-head, and Water, now weighed 8255 Grains; whence the Weight of the Water, taken out, was 520 Grains. Then pouring off the Water, in the Cane, we filled it with Oil of Vitriol, and pouring it into the Bolt-head, we found it not to fill the former Space, and to make a considerable Heat in the Water, and many small Bubbles to rise: We then weighed it again, and found the Bolt-head, and Mixture, to weigh 9210 Grains; whence we found the Weight of the Oil of Vitriol to be 945 Grains: We let the Mixture stand about Half an Hour, by which

Time

Time we found they were so condensed, that 5 Inches and half, of the 18 Inches and half, of the Neck, were left empty, which is near a third Part of the Dimensions of the Oil of Vitriol, that was poured therein; then we filled up the Vacuity, and found it to contain 138 Grains; which compared to the whole Bulk of Water, that fill'd the Bolt-head, is between a 48th and a 49th Part; for as 138 to 6689 $\frac{1}{2}$, so 1, to 48 $\frac{1}{2}$ $\frac{1}{8}$.

FROM which Observations I deduce, that in this Experiment there is somewhat more than a bare Mixture of Fluid with Fluid, as of Water with Water; where tho' they may intimately mix, and temper together, and become one uniform Fluid, yet each of them, and every Part of each, keeps its former Dimensions and specifick Gravities; or of Water with Wine, Ale, or the like inspissated Liquors; or with saline Solutions, as of Salt, Niter, Allum, Vitriol, &c. In all which, I conceive, that there is nothing but a mixing, tempering, or dilating, as in the Mixture of two Liquors of the same Kind. Now, as I formerly hinted, I do not at all doubt, but that there may be found many other Liquors which may have the like Effects, one upon the other, upon Mixture; so that there may be also found Instances of a differing Nature, where the Mixture shall increase the Dimensions of the Particulars, and diminish the specifick Gravity, either of one, or both. But I think there have not yet been produced any Instances of these, or the other Kind, at least, I think, they have not yet been proved such.

Mr. Waller recommended the Trial of this Experiment to Mr. Hawkesbee, and if the Reader hath a Mind to see the Success thereof, he may find it in the *Philos. Transf.* of 1711. N^o 331.

WILLIAM DERHAM.

An Account of the Plant, call'd Bangué, before the Royal Society, Dec. 18. 1689.

IT is a certain Plant which grows very common in *India*, and the Vertues, or Quality thereof, are there very well known; and the Use thereof (tho' the Effects are very strange, and, at first hearing, frightful enough) is very general and frequent; and the Person, from whom I receiv'd it, hath made very many Trials of it, on himself, with very good Effect. 'Tis call'd, by the *Moors*, *Gange*; by the *Chingalese*, *Comsa*, and by the *Portugals*, *Bangué*. The Dose of it is about as much as may fill a common Tobacco-Pipe, the Leaves and Seeds being dried first, and pretty finely powdered. This Powder being chewed and swallowed, or washed down, by a small Cup of Water, doth, in a short Time, quite take away the Memory and Understanding; so that the Patient understands not, nor remembereth any Thing that he seeth, heareth, or doth, in that Extasie, but becomes, as it were, a mere Natural, being unable to speak a Word of Sense; yet is he very merry, and laughs, and sings, and speaks Words without any Coherence, not knowing what he saith or doth; yet is he not giddy, or drunk, but walks and dances, and sheweth many odd Tricks; after a little Time he falls asleep, and sleepeth very soundly and quietly; and when he wakes, he finds himself mightily refresh'd, and exceeding hungry. And that which troubled his Stomach, or Head, before he took it, is perfectly carried off without leaving any ill Symptom, as Giddiness, Pain in the Head or Stomach, or Defect of Memory of any Thing (besides of what happened) during the Time of its Operation. And

he

he assures me, that he hath often taken it, when he has found himself out of Order, either by drinking bad Water, or eating of some Things which have not agreed with him. He saith, moreover, that 'tis commonly made Use of, by the Heathen Priests, or rambling Mendicant Heathen Friars, who will many of them meet together, and every of them dose themselves with this Medicine, and then ramble several Ways, talking they know not what, pretending after that, they were inspired. The Plant is so like to Hemp, in all its Parts, both Seed, Leaves, Stalk, and Flower, that it may be said to be only *Indian Hemp*. Here are divers of the Seeds, which I intend to try this Spring, to see if the Plant can be here produced, and to examine, if it can be raised, whether it will have the same Vertues. Several Trials have been lately made with some of this, which I here produce, but it hath lost its Vertue, producing none of the Effects before-mentioned; nor had it any other Operation, good or bad, since I receiv'd it with this Account I have related; imagining I had met with somewhat like it in *Linscotten's Voyages*, which the Reader may peruse at his Leisure.

I HAVE formerly given an Account of the Effects of the Roots of *Hemlock*, accidentally eaten by some young Children, which, at first, had an Operation on them much of the like Nature with this Vegetable; and possibly the last Effects might not have been much differing, if they had not made Use of Medicines, to recover them out of the Trance, before the Period of its Operation, tho' that be uncertain, and wants Experiences to ascertain it. Whereas this I have here produced, is so well known and experimented by Thousands; and the Person that brought it has so often experimented it himself, that there is no Cause of Fear, tho' possibly there may be of Laughter. It may there-

fore, if it can be here produced, possibly prove as considerable a Medicine in Drugs, as any that is brought from the *Indies*; and may possibly be of considerable Use for Lunaticks, or for other Distempers of the Head and Stomach, for that it seemeth to put a Man into a Dream, or make him asleep, whilst yet he seems to be awake, but at last ends in a profound Sleep, which rectifies all; whereas Lunaticks are much in the same Estate, but cannot obtain that, which should, and in all Probability would, cure them, and that is a profound and quiet Sleep.

Observations about Gems, and other valuable Commodities, extracted by Dr. Hook, Dec. 15. 1690. from Captain Knox's Journal; which I think worth publishing, by reason they are Rules observed at this Day.

Directions for Knowledge of Bezoar Stones.

THE Monky Bezoars, which are long, are the best; those, that are rough, prove commonly faulty, breaking with Stones in the Middle; others in Form of Tuns, somewhat flat, which break in smaller Stones in the Middle, are better than the rough ones. Bezoar is tried fundry Ways, as the rubbing Chalk upon a Paper, then rubbing the Stone upon the Chalk; if it leave an Olive Colour, it is good; also touch any with a red-hot Iron, which you suspect, because their Colour is lighter than ordinarily they use to be; and if they fry, like Rosin or Wax, they are naught. Sometimes they are tried by putting them into clear Water; and if there

there arise upon them small white Bubbles, they are good, if none, they are doubtful; the Use of the hot Iron is esteemed infallible.

It is best to buy *Musk* in the Cod, for so it will be preserved; that which openeth with a bright Musk Colour, is the best. When taken out of the Cod, if a little chewed, and rubbed with a Knife on thin Paper, it look smooth, bright, or yellowish, 'tis probably good; but if of a Colour, as 'twere mixed with Gravel, 'tis bad; the Goodness is best discovered by the Scent.




Ambergreece, the best is Grey. For Trial, if a little be chewed, and yield an odoriferous Flavour, feeling, in Substance, like Bees-Wax, 'tis good, else not.


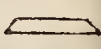
The Names of Precious Stones.

Diamond, Ruby, Saphir, Emerald, Topas, Hyacinth, Amethyst, Garnet, Chrysolite, Turcois, Agate, Splen, Jasper, Lapis Lazuli, Opal, Vermilion, Cystropic, Cornelian, Onyx, Bezoar.

THE *Diamond* is the hardest, and, when cut, the most beautiful of all Stones: In Knowledge whereof, there is great Difficulty, having a Crust on them before they are cut; therefore Caution to be used in buying them is before-hand, to make a Pattern in Lead; their Waters are White, Brown, Yellow, Blue, Green, and Reddish; whereof take Notice, rating them according to their Waters; in our Climate, the perfect white Water is most esteem'd. *Brut-Stone*, or rough and un-cut Stones, are in Value half the Price of cut, or polish'd Stones; neither too thick, nor too thin in Substance, is best. A thick Stone, which is high and narrow, fable, not making a Shew answerable to its Weight, must be valued at less than that which is well spread, hath its Corners perfect, and a pure white Water, without Spots or Foulness, is called a *Paragon-Stone*,

and in full Perfection. Un-cut Stones are distinguished into two Sorts, thick or pointed, which are called *Naif*-Stones, and flat Stones ; the flat Stones are to be cut into Roses, or thin Stones ; the *Naif* into thick Stones ; and those rough Stones, which will bear a good Shape, with least diminishing in cutting, are in best Esteem.

The Names of rough Stones, according to their Form and Substance : The rough Diamonds, that seem greenest, prove of a good Water, when cut ; those that seem white, when rough, grow bluish often, when cut.  A Point.  A half Point. 

A thick Stone.  A half ground Stone. 

A thin Stone.  A Rose Stone, if round ; if long, a *Foseel*.  A *Naif*. Care is also to be

taken in Choice of rough Diamond, to avoid those that have Veins ; for they will never cut well, but seem as filed with a rough File. For vending, Stones of six Grains, or under, to one Grain and half, are best. *For Trial of a Diamond* ; Take a pointed Diamond, such as *Glaziers* use, try it on any Stone but a Diamond, and it will cut it. The Diamond that is of a sandy, or hath any Foulness in it, or is of a blue, brown, or yellow Water, is not worth half the Price of a perfect Stone, of a white Water.

For cutting of Diamonds : You must never mould any of them in Sand, or Cuttle Bone, but you must use the second Lead to make a Pattern of, because the first will come somewhat less than the other ; never cast it off, but of the perfect Lead ; then make a Pattern of it ; but first weigh the Lead, and set down the Weight ; after, form the Lead to the best and most advantageous Shape, for the Stone, then re-weigh the Lead again, and set down the Weight ; by which you may see what the Stone will lose, by cutting to that Shape ;

the Lead is three times the Weight of the Stone : This is a fure Rule, commonly it loseth about $\frac{1}{8}$ Part in cutting.

To make Diamonds clean : If you see a thick Table-Diamond in a Ring, a Jewel, or in a Locket for a Jewel, you must first make it clean, either with a little Pumice-Stone, or with a few hot Ashes, or with a little Oil, and boil it, 'twill make it very clean.

Valuation of Diamonds : There is a Rule accurately to be observ'd ; which is, a Stone of one Carack is worth 10*l.* One of two Caracks is worth $2 \times 2 \times 10 \text{ l.} = 40 \text{ l.}$ One of three Caracks is $3 \times 3 \times 10 \text{ l.} = 90 \text{ l.}$ This, for even Caracks, comes nearest the true Value ; but for $\frac{1}{2}$, or $\frac{3}{4}$ of a Carack, tho' a Stone of two Caracks be worth 40*l.* yet, in this Rule of Reckoning (meaning $\frac{1}{2}$ a Carack so valued) it is valued but at $\frac{1}{4}$ of a Carack, which is 50*s.* and one of $\frac{1}{4}$ of a Carack but at $\frac{1}{4}$ of 50*s.* tho' a single Stone, one Quarter of a Grain, or $\frac{1}{4}$, worth 30*s.* as for Example. You would know what a Stone of six Grains is worth ; six Grains is $3\frac{1}{2}$ Caracks ; 3 times 3 is 9, and 9 times 50*s.* is 22*l.* 10*s.* which is the Value of the Stone. So of five Grains, 5 times 5 is 25, and 25 times 12*s.* 6*d.* is 15*l.* 12*s.* 6*d.*

To make a Foil for a Diamond. A Foil, to be set under a thick Table-Diamond, is made with black Ivory and Mastick, picked, and made very clear, with a little Oil of Mastick, to incorporate them. Black Ivory and Turpentine, heated on the Fire, is good, but the former is better. For a thin Table, black Ivory, scraped very fine, is good ; or take a Coal of the said Ivory, with a little Oil of Mastick, and dry the same ; or Ivory, with a little Gum ; fair Water, is also good.

If you sell a Diamond, that hath high Bissals, then you may set it upon full-scraped Ivory, which graceth the Play of them.

A R O S E Diamond, that is very thick; it's good to set it close upon the Ivory, and it will play very well; or black Velvet is good, under a thin Table Diamond, scraped as you do Lint.

T H E R E are four Sorts of *Oriental Rubies*; that which is hardest, the best and fairest Colour, if it be very fair, and cut Diamond-cut, is no less esteem'd than a Diamond, for the Weight; but 'tis rare to see such an one. The second Sort of Rubies is white, oriental, and hard, which also is of good Esteem, if cut of a Diamond-cut, but not of so high a Price, as the perfect red Ruby; but yet if it be in Perfection, 'tis very rare, there being few of this Sort. The third Sort is called a *Spinell*, which is softer than the former, and of less Esteem, being not so hard, nor hath it the Life of the other, nor so perfect a Colour: 'Tis naturally somewhat greasy in cutting because of its Softness. The fourth is called a *Ballace Ruby*, not so much esteem'd as the *Spinell*, being not so well colour'd; 'tis also greasy, and will scarce take a Polish, and looks like a *Garnet*.

T H E R E are three Sorts of *Saphirs*; one perfect blue, and very hard, which if cut of a Diamond-cut, and without *Calcedonie*, is of very good Esteem. The second is perfect white, and very hard, which if of a Diamond-cut, and without Blemish, is likewise esteem'd. The third, call'd *Water Saphirs*, are of small Esteem, being not so hard as the other, and commonly of a dead waterish Colour.



A Copy of the Account, which Dr. WALLIS gave to Dr. BERNARD, one of the Delegates for Printing, by a Messenger sent from Oxford for that Purpose, the Delegates having agreed to be determined by his Opinion in the Case, at Serjeant's-Inn, in Fleet-street. Jan. 23. 1691.

Reverend S I R,

IN Answer to yours, of *June 20.* concerning the Business of *Printing*, the brief History is this:

As to the University's Right of Printing all Manner of Books vendible, before our Charter of King *Charles I.* it is not needful to trouble you at present; but the Use of Printing was first brought into *England* by the University, and at their Charges, and here practised many Years, before there was any Printing in *London*; and we have been in the continual Possession of it ever since, and long before there was any Restraint put upon Printing, which was not at all, till Queen *Elizabeth's* Time.

ABOUT 8 *Car. I.* (and by several Charters since) our ancient Right is recognized, and further granted to us; besides which Charter, Archbishop *Laud* did procure, from the *Stationers* of *London* (by Indenture under their Seal) a Grant from them of one Copy, for the *Bodleian* Library, of all Books thenceforth to be printed in their Company, in Consideration of a Lease, to them granted, of transcribing Copies (in that Library) of Manuscripts there, for them to print. And Sir *Thomas Bodley* gave to the Company a Piece of Plate of 60 *l.* But this, tho', for some Time, whilst

whilst Arch-Bishop *Laud* lived, 'twas, in Part, observed, hath since been wholly neglected, and they give us none upon that Account.

THERE was, at the same Time, an Agreement between the University, and that Company, (for three Years) in behalf of the Company, the King's Printers, and Mr. *Norton*, (with a Covenant to renew at the End of that three Years) whereby the University agreed to forbear the Printing of certain Books, and the Company to pay 200 *l.* a Year for such Forbearance, which 200 *l.* was, by Agreement among themselves, to be raised in a certain Proportion; *viz.* So much by the Company, so much by the King's Printers, and so much by Mr. *Norton*. But as to this Partition between themselves, the University was not concerned. This 200 *l.* was paid for the first three Years, and the Agreement renewed, with like Covenants, for another three Years, and observed by them for some Time; but, the Wars coming on, the University did still forbear Printing, but the Stationers gave us no Money; and thus it continued till about the Year 1653. nor would the Company be prevail'd with, either to renew their old Agreement, or enter into any new one, to that Purpose; but did enjoy the Benefit of our Forbearance, without giving us any Consideration for it.

THE University thereupon gave Leave to their Printers (*Litchfield* and *Hall*) to comprint with them divers beneficial Books, which presently brought them to such Terms of Agreement, (that being the only Means to bring them to Reason) tho' it was then agreed to forbear, they paying the Rent of 120 *l.* which Fall of Rent was agreed to, upon their Complaint of Poverty and Decay of Trade.

AFTER the Return of King *Charles II.* Dr. *Bailey*, when he was Vice-Chancellor, brought it up to the old Rent of 200 *l.* and so it continued for some While.

WHEN the University devolved their Power on Dr. *Fell*, (since Bishop of *Oxford*) and some others, they continued the like Agreement, with the Company, in behalf of themselves, and some others concerned with them, which continued for some Time longer.

BUT after a While, the King's Printers of Bibles, presuming that we had not Stock enough to comprint Bibles with them, broke off their Agreement, and would pay their Proportion no longer; bidding us print Bibles, if we pleased, they would give us nothing to forbear.

MEAN while the Company and Mr. *Norton*, being well aware that we might, with a little Stock, be able to do them a Prejudice, by printing Grammars, Almanacks, and School-Books, were willing to continue the Agreement, as to their Proportions.

WHEREUPON the Bishop and Dr. *Tates*, continuing to pay us 200 *l.* as before, did agree with the Company and Mr. *Norton*, for so much as their Proportion came to, but did bear the Loss, out of their own Purfes, of that which the King's Printers were to pay; and this for divers Years, before they could put themselves into a Capacity of printing Bibles.

AFTER some Years, Dr. *Tates* brought into the Stock, for Printing (as I have been told) a Stock of 4 or 5000 *l.* which did inable them to set upon the printing of Bibles.

THEREUPON the Bishop and he printed a Bible in *Quarto*, which the King's Printers, being aware of, did print another, just in the same Volume, and sold it to Loss; and did lose by it, as themselves

themselves did acknowledge, above 500*l.* designing, thereby, to break our Design in Printing, by forcing us to sell so cheap, as to lose by it, or else to have the Bibles lie upon their Hands unfold; whilst themselves would make themselves whole, by setting a higher Price on Bibles in other Volumes: And thus they threatened to do, with whatever Volumes we should print, presuming that we were not in a Capacity to print in all Volumes.

THE Bishop and Dr. *Tates*, finding themselves thus over-reached, found it necessary to take in with them some *London Booksellers*, as well for the better vending of Books, which did already lie upon their Hands, as for the Increase of their Stock, that they might be in a Capacity to print in other Volumes also, which did effectually counterwork that Design.

HEREUPON they first took in *Moses Pitt*, and one other; but finding these not enough to do the Work, they further took in Mr. *Parker* and Mr. *Guy*; those took off all the Books which the Bishop and Dr. *Tates* had lying upon their Hands, and did effectually set upon printing of the Bible in several Volumes: With so much Struggling it was, and with so great Charges, before we could get into a Capacity to print Bibles, without great Loss.

THIS Difficulty being thus master'd, their next Attempt upon us was by a Suit at the Council-Table, about the Year, as I remember, 1679, which put us to 2 or 300*l.* Charges; which was born partly by the University, partly by the Bishop, and partly by our Printers, endeavouring, thereby, to get us restrained from printing Bibles at all, or, at least, confined only to some few Sorts; in which Suit, Mr. *Pitt*, Mr. *Parker*, and Mr. *Guy*, were very industrious, and diligent in soliciting the Business, retaining and instructing the Council, and giving

us other Assistance, which we could very ill have spared; the present Bishop of *St. Asaph*, and other Friends, were likewise assistant to us.

THE Issue of this Suit going for us, their next Attempt was, the setting a Multitude of Presses to Work, to print vast Numbers off, and by selling them cheap, to break our Printers; so that now the Contest was, whether should print most, and sell cheapest; whereby the Price of Bibles, for the Advantage of the Publick, was brought down to less than Half of what they were before sold at; and many hundred Thousands of Bibles, printed and sold, more than otherwise would have been; and our own People at home, and abroad in our Plantations, furnished from hence, which before were wont to be furnished in vast Numbers from *Holland*, where Bibles were printed, far more than in *England*, because cheaper; for the King's Printers did not, now, print and sell fewer Bibles, by reason of our Comprinting, but only they sold them cheaper.

THEIR next Attempt on us, was a long Suit in Chancery, for two or three Years, to the Charges of a great many hundred Pounds, born as before, partly by the University, partly by the Bishop, and partly by our Printers; wherein we thought, the Lord-Keeper *North* bore very hardly upon us (and was afterwards convinced that he had done so) but did at length dismiss us, to a Trial at Common Law: After which, if there were Occasion, it was to return again to Chancery.

AFTER this, they vexed us with two Suits at Common Law, which are yet depending; one in the Name of the King's Printers; the other in the Name of the Company; to which we were fain, at great Charges, to put in Pleas, and to have it agreed at the Barr divers Times; but finding the Court inclinable to do us Right, they have, by delaying Proceedings, kept it off from Judgment, and the Suits are still depending.

THEY

THEY then prevailed with the Bishop of Oxford to separate the Interests; and whereas before, while Dr. *Tates* was alive, they had let the whole to our Printers, at 200 *l.* and left it to them to agree with the Company, upon the Point of Forbearance, who knew, better than we did, how to hold the Company to their Agreement: The Bishop would let, to our Printers, the Business of printing Bibles and Common-Prayer Books at Part of that Sum, and agreed with the Stationers for another Part of that Sum, to forbear printing their Copies; and this by Agreement between the University and the Stationers, for three Years, with a Clause of Renewal after that Time.

THE Stationers now being got free of our Printers, who knew how to keep them to Terms, (better than we) they broke with us: They paid their Rent for about one Year, but then first delay'd, and then refus'd to pay their Rent, till there was five Quarters behind, and told us we should be paid all the next Term, upon the *Quo Warranto*.

FOR in the Interim of this their Delay, to pay their Rent, they had caused a *Quo Warranto* to be brought against the University, of which they hoped the like Issue, as of the other *Quo Warranto*'s; towards the obtaining of which, we are told of a Plate of 500 Guineas went one Way, and a Tun of Wine another Way; and 300 *l.* allowed to *Henry Hill* upon his Account, for secret Service; and of a Bible to be presented to somebody (with silver Clasps and Bosses, &c.) which cost 60 *l.* the Binding; but these being Works of Darknes, I cannot tell what to say to them; but this we are sure of, that the *Quo Warranto* was brought, and that 14 of the chief Men of the Company did, at once, attend at the Attorney-General's Chamber, when it was there to be argued; though they
would

would now persuade us, that it was only *Henry Hill's* Doing.

FOR this Arrear of Rent we did commence a Suit, (which is, I think, yet depending) but the *Quo Warranto* being then actually brought (which they hoped should pay all their Debts) we were advised, as a quicker Way (they having broken their Articles, by Non-Payment of Rent) to forbear no longer, but comprint upon them, which presently brought them to Order; and, (notwithstanding the *Quo Warranto* depending) brought down their Money, and would have paid, not only the five Quarter's Arrears (for which we had commenced the Action) but another Quarter's Rent too, which we could not safely receive, because we had comprinted upon them; but would not pay those Arrears, unless we would take that further Rent; and so that Arrear, and all the Rent, ever since remains unpaid by them to this Day.

'TIS true, that *Parker* and *Guy* did then deposit, with the Vice-Chancellor, Dr. *Ironside*, that Arrear of 240 *l.* or rather so much Money instead thereof, and all the growing Rent ever since; and also, at their own Charge, of 200 *l.* at least, maintain that Suit of the *Quo Warranto*; which Kind of Law-Suits were wont to be partly born by the University, and by the Bishop, hoping, in Time, to make themselves whole again from the Company, but (for some Reasons) cannot do it yet; and never meant, if they continue our Printers, to trouble the University to get in those Arrears, or Charges, because they think they can get it in, easier than we can, if we do not disable them.

BUT if we take our Power out of our own Printers Hands, whose Interest it is, as well as ours, to preserve it, and put it into the Hands of those, whose Interest it is to destroy it, we shall disable both them and ourselves for recovering
those

those Arrears or Charges ; and whatever Agreement we make with them, we may expect (upon the first Opportunity) to have them broken, as hitherto they have been ; and if we once let fall our Printing, we can never hope to recover it again ; for where shall we find another *Dr. Yates*, to furnish us with such another Stock, and run through the many Difficulties to re-establish what we now have, and may continue, without Trouble, if we please.

ON the other Hand, I do not know that *Parker* and *Guy*, who are now your Printers, have ever failed in paying you, to a Penny, whatever they promised ; nor do I find that the Company do charge them to have ever failed in any Agreement made with them, tho' but verbal.

THIS is the Account, which, as to Matter of Fact, I can on the sudden give you, from

S I R,

Tours to serve you,

JOHN WALLIS.



Dr. HOOK's Description of some Instruments for Sounding the great Depths of the Sea, and bringing Accounts of several Kinds from the Bottom of it. Being the Substance of some of his Lectures, in December, 1691.

IN the *Philos. Transact.* N. 9. and 24. we have a Description of an Instrument, to sound the greatest Depths of the Sea: But there were two great Difficulties that attended it: The first was, That it was necessary to make the Weight, that was to sink the Ball, of a certain Size and Figure, so proportioned to the Ball, as that the Velocity of them, downwards, when united, should be equal to the Velocity of the Ball alone, when it ascended in its Return; in Order to which, it required to be prepared with Care, and required also some Charge, it being almost necessary to make it of Lead, of a certain Weight and Figure. The other was, the Difficulty of discovering the Ball at the first Moment of its Return, which was likewise of absolute Necessity; and it was likewise necessary to keep the Time most exactly of its Stay, or Continuance, under the Surface of the Water, by the Vibrations of a Pendulum, held in one's Hand; for I was inform'd, that, upon Trial, they have, after some Time, perhaps discover'd the Ball floating in a Place, where they did not at first expect it; and so that Experiment became insignificant, tho' they were at the Charge of losing the leaden Weight, and had used all Diligence to keep the Time, and to watch for the first Appearance of the Ball.

THIS Way, which I shall now explain, is freed from all these, save only of finding and recovering the Ball, after it is returned from the Bottom; for I have no Need of proportioning my Weight, provided it be heavy enough to sink, nor of making it of this, or that Figure, or of Lead, or any other Metal, since a Stone, if big enough, of any Shape, will do; nor have I any Need of counting the Time of its being under Water, since it will do as well, if I procure the Ball an Hour after it floats; so that all the Trouble is, the fetching in the Ball, when 'tis discovered, and the letting it into the Water, when it begins to sink.

It remains therefore only to describe the Means and Way, how this Matter is to be effected, and 'tis, in short, no other than what I then experimented, and gave an Account of, in Writing, to this Society; as, I believe, will appear by the Register of that Time, which was, as well as I can remember, in the Year 1661, or 1662; but because few here, now present, may remember it, I shall now again describe it.

It consists then of three Parts; the first is a Stone, of a sufficient Bigness, to sink it to the Bottom, how deep soever; and the bigger the Stone be, the more Expedition doth this Messenger make to its Stage. Secondly, of a wooden Ball, well pitched, which is carried down, by the Stone, to the Bottom, which then leaving it, it returns, with Speed, to the Top, and there floats upon the Water, from whence it is to be fetched aboard. Thirdly, of a Cylinder, Cone, or Hyperbolick Trumpet, that is to bring back the Information to what Depth it hath descended; this is fastened to the Ball, in the Manner described in the Figure; and at the Bottom of this is fastened the Cock, or Crook, by which they are both pulled down to the Bottom, and then let loose, as was practised

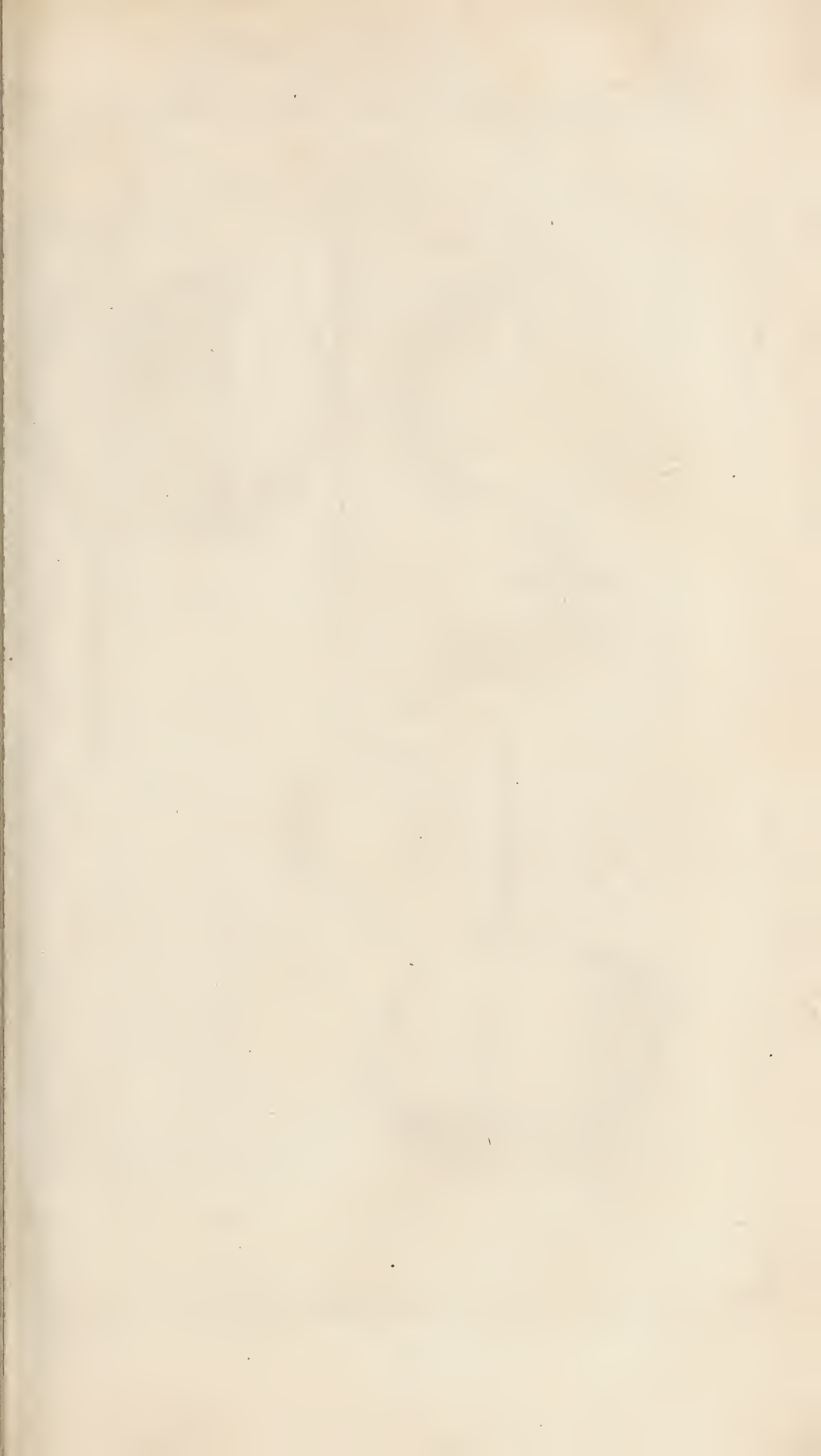


Table 1

Fig. 1.

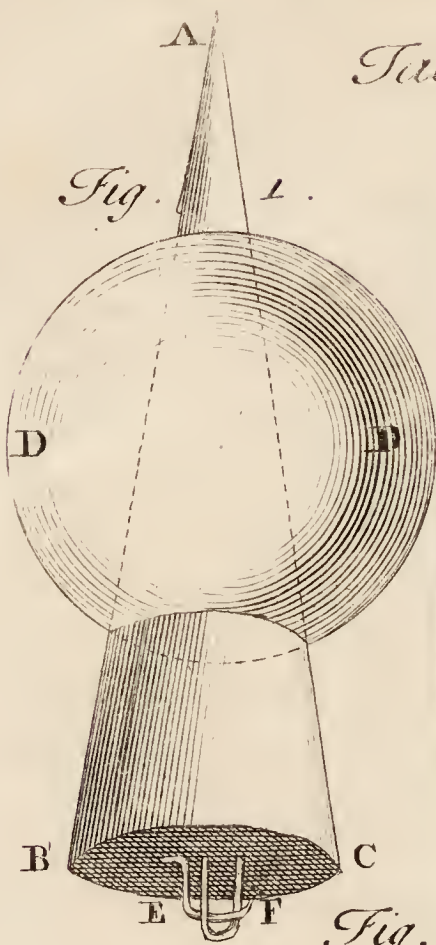


Fig. 3.



Fig. N M 2.

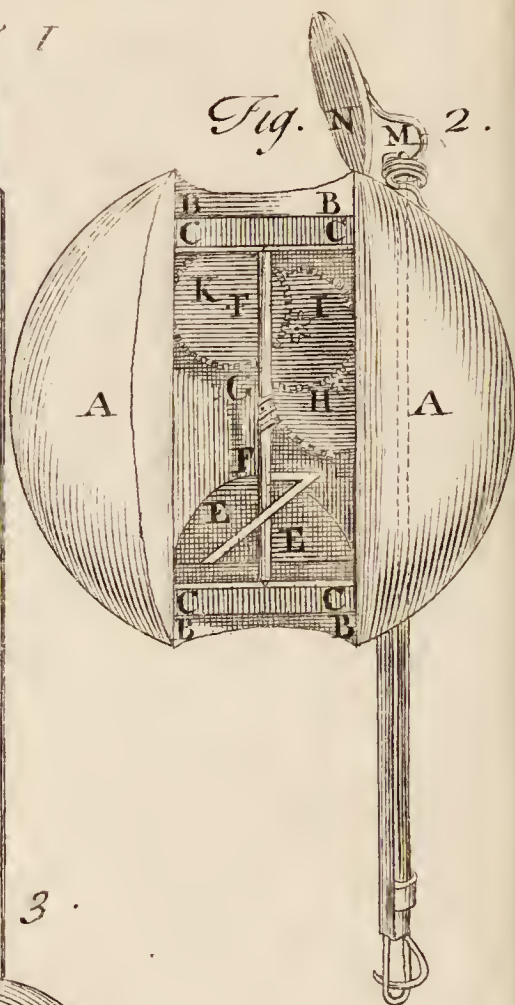


Fig. 233

Fig. 232

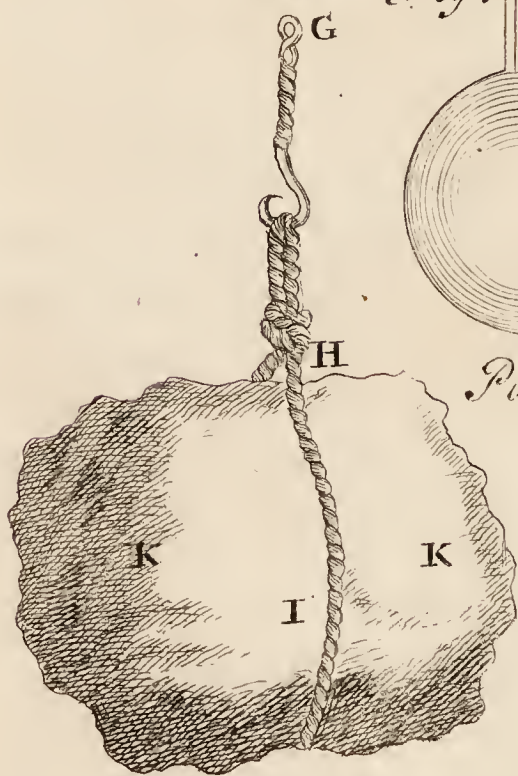


Fig. 227.

on the former, described in the *Philosophical Transactions*.

THE Cylinder, Hyperbolick Trumpet, or Cone, (*Tab. III. Fig. 1.*) ABC is to be hollow, made of Tin, or thin Brass, and so contrived, as, by a small Hole, to receive the Water into it, less or more, according to the external Pressure at the Apex A, of the Fluid it descends in; so that it will always, by the Quantity of Water contain'd in it, give a true Account of the Pressure of the Water, at the Bottom, which is always proportionate to the Depth of it, below the Surface; this is shewn by the Compression of the Air included, whose Dimensions are always in reciprocal Proportion to the Pressure. This is to be found after the Ball is returned from the Bottom, by weighing the Quantity of Water, contain'd in the Cone, or other Receiver, and comparing it with as much Water, as will exactly fill it, or by a Measure of Capacity; or thirdly, if the Receptacle be perfectly regular, by a gauging Rod set in its Axis; but the best, and most sure Way, I take, to be by Weight. DD is the Ball, made of light Wood, and well pitch'd, and of sufficient Bigness, to raise up the Cone, with its contained Water, as soon as it is discharged from the Stone or Weight. KK, which is to be of a Weight sufficient to sink it, and then slip from it, at the Bottom, by Means of the Spring-Hook; EFG the Ring to be hung upon the Hook; FHI the Cord. There is nothing in the Contrivance, but what is easy to be made, and the Charge will not amount to a Farthing a Trial.

Emissarius secundus ad fundum Abyssi, sive
Explorator Distantiæ Inanimatus.

THE Opinions, concerning the Abyss, seem to have been received, and conveyed to us, from the first and most ancient Times of the World. And we find that *Ovid*, tho' he seems to have understood the Earth to be Spherical, yet he, speaking of the Creation, and first Production of Things, (of which, no doubt, he received his Information from the Writings of *Moses*, or some other that had seen them) makes the Water to be the lowest of all the Elements ——— *Circumfluit humor ultima possedit solidumque coercuit Orbem*. I had no further Intention, but to shew, that the Sea was call'd the Abyss, and by the Abyss was meant a Depth, not possible to be sounded, or measured, by the Power of Art: But it is more properly rendered, by our *English* Translation of the Bible, *the Deep*, or *the great Deep*, (when the Depth of the Sea is meant) than by the Abyss in the *Vulgar*; yet there are several Expressions that do shew, it was understood to signify a Depth, that was beyond the Power of Man to measure; and so it seems to be meant in the first Chapter of *Ecclesiasticus*, where 'tis said, *Who hath measured the Height of Heaven, the Breadth of the Earth, or the Deep*; that is, the Profundity of the Sea. And so the Expression in the 37th Chapter of *Job* seems to intimate: The Expressions in the Scripture, relating to Physical Matters, being accommodated generally to the most common and believ'd Opinions of Men, concerning them. Certain it is, that no one, yet, hath experimentally found what the greatest Depth of it is, except only in such Places as are measurable by Lines and a Plumbet, and that, for the most Part, near some Land. The greatest
that:

that I have met with, of that Kind, which I can rely upon, is, what Mr. *John Greaves* relates, that he tried in the Sea. The Passage is in the 102d Page of his *Pyramidographia*. In the Longitude of 11 Degrees (says he) and in the Latitude of 41 Degrees, having borrowed the Tackling of six Ships, and, in a calm Day, sounded, with a Plumbet of almost 20 Pound Weight, carefully steering the Boat, and keeping the Plumbet in a just Perpendicular, at 1045 English Fathoms; that is, at about an English Mile and a Quarter, in Depth, I could find no Land or Bottom. These are his Words; but where this Place was, I cannot define, because he does not declare from what Meridian he computes his Longitude: Whether it were in the Ocean, to the Westward of *Portugal*, or in the *Streights*, about *Merseilles*; where-ever it were, it was an excellent Place, to have tried many curious and instructive Experiments, that might be there tried, by such as have Opportunity to go that Way again, if it were certainly known. But this Depth is nothing, in Comparison to what *Hesiod* supposes it, or *Tartarus*, which is the same Abyss; namely, as deep downwards, as the Heaven is high upwards; and that he asserts to be so high, that an iron Axe would be 10 Days in falling, before it would touch the Earth; and just so long would the Axe be falling, before it would arrive at *Tartarus*. But to leave these Poetical Fictions, certain it is, that the Sea is, in some Parts of it, very deep, and it would afford many useful Informations, if Inquiries were carefully made, by Means of my *Explorators*, or *Nuntii Inanimati*; for by some, or other of them, one might be ascertain'd of divers Things, yet, never known to Mankind. That which I described, the last Day, was, for measuring the Distance, which it would effectually do, were it not for one Objection or two,

which may possibly render its Account disputable. The Power of the Spring of the Air, is most certainly in reciprocal Proportion to its Dimensions, to whatever Bulk the same Air be reduced to, by Compression; 'tis certain also, that the Compression, or Trusion, of a fluid Body, is always in Proportion to the Length of the Cylinder compressing; so that the Power of compressing of any one Cylinder, of a certain Height, being known, the Power of any other Cylinder, whose Length is given, is easily found. The like is to be estimated concerning the Powers of the Resistance of the Air, if its Power of Expansion, or Resistance to Condensation, be known, for any one Expansion, or Dimension of it; the Power of Expansion is known, for any other Dimension of it given. So that both the Principles, upon which the last Day's Experiment was founded, are undoubtedly true and genuine, and consequently the Invention, thereupon founded, would succeed; and then, the first *Nuntius Inanimatus* would be a true *Explorator Distantiæ*. But there are two Things that may make its Information dubious; the first is, the Uncertainty of the Temper, as to Heat and Cold, in those very deep, sub-marine Regions. For we know that Heat does augment the Power of Expansion in the Air, and Cold doth diminish it; and therefore it will be uncertain, whether all the Contrusion of the Air, at the Bottom, be to be ascribed to the Gravity of the incumbent Cylinder of Water, or to the Coldness of the Water of those Regions, in Part; till therefore the Temperature of those Regions be known, we cannot positively affirm, what Part of its Condensation was to be ascribed to the incumbent cylindrick Weight of the Water.

Explorator Temperamenti.

To know this, I have another Messenger, call'd *Explorator Temperamenti*, which shall fetch a true Account thereof; and so that Objection, or Impediment, would be easily enough removed, if Need were.

BUT there is another Objection (which is also very material) against the aforefaid Method, and that is this, That, as 'tis true, that if the Water, at the Top and the Bottom of the Sea, were all of an uniform Nature, then the Rule for its Gravitation, or Pressing, would hold exactly according to the Rules of Proportion, I have before premised, and the Deductions therefrom would be indisputable; but if there be differing Sorts of Water, in differing Depths, as no one has yet ascertain'd us of the Contrary, then differing Sorts of Water will give differing Degrees of Gravitation, or Pressure; and the Proportion I have assign'd, for an uniform Cylinder of Water, will no longer be of Use; for if the Water in *Specie* be heavier, (as most probably it is) then a shorter Cylinder of it will have the same Power to press, that a longer Cylinder hath, of a Water lighter in *Specie*; so that if the Water be twice as heavy, half the Weight will produce the same Effect; and if thrice the Weight, then a third Part of the cylindrick Weight will be only necessary; and if it should be as heavy as Quicksilver, or indeed as heavy as the Stone, or Weight, that sinks the Ball; then the *Explorator* will not dive into it at all, but stay at the Top of it. It is necessary therefore, that we be ascertain'd of the Nature and Condition of the Water, or Liquor, whatever it be, at the Bottom, or in those lower Regions, at any assignable Depths.

Explorator Substantiæ.

AND for these Purposes I have other *Explorators*, that shall bring me a certain Account, what Kind of Water, or other Liquor, it is that possesses such, or such a Depth, be it 500, or 1000, or 1500, or 2000 Fathom deep, or any other greater, or less, assignable Depth; these I call *Exploratores Substantiæ*, and of these I have several Kinds, according to their several Employments and Business. There is yet another Scruple that must be removed also, and that is, Whether the Gravitation, towards the Center of the Earth, do continue the same, at any Depth; or whether it do increase or diminish, according as the Body is posited lower and lower, beneath the Surface of the Sea; for if Gravity do increase, then the Body will move downwards, or sink faster, than at the Top; and if it decrease, it will do the Contrary. Now there have been many, and, among the rest, the incomparable *Verulam*, that have affirmed, that Stones, &c. in the Bottoms of deep Mines, do weigh much lighter, than at the Top; if so, why may not that be true also, of the Depths in the Sea: However it be, it is desirable, in Philosophy, to be ascertained, whether it be so or not; and if it be so, what the Differences really are; for which Purposes I have other *Nuntii* or *Explorators*, that shall certainly inform me, concerning those Particulars also. There are many other particular Inquiries, which one would desire to be ascertain'd of, which I shall afterwards mention, and also furnish or supply Messengers, sufficiently accoutred, to bring back Informations, certain and instructive. But I shall not trouble you with them at present; but if there be an Opportunity of trying these I have named, and many other I could enumerate,

I shall

I shall be ready to give my Assistance: They are Experiments indeed, not to be tried in the Presence, or at the Meeting of this Society, but yet they are such, as it were, very desirable, that the Society had a true Account of them; as there are also Thousands of others, which, it were to be wished, this Society would procure Informations of; which, I conceive, is in their Power to effect, if due Means and Methods were made use of, for effecting those Ends. The Harvest is great, but the Labourers are few; and without Hands and Heads too, little can be expected; and to rely only upon Time and Chance, is, probably the most likely Way to have all our Hopes frustrated.

Explorator Profunditatis.

BUT to leave this Digression, I shall, at present, only describe another Messenger, who is to be *Explorator Profunditatis*, or a true Surveyor of the Distance, which is not at all liable to the Uncertainties of the last, or any other, as I conceive; for be the Heat or Cold, of that Climate, what it will, or whatever the Density or Rarity, whatever the Gravity or Levity of the Water, whatever the gravitating Power, whether the same, greater, or less, whatever the Spring of the Air be, &c. none of these, or any other, that I can think of, will be material, but the Messenger will return, with a true Account of what he was sent to inquire.

THIS *Explorator* has divers Parts, much the same with the former; as first, a large Ball of Wood, or (*Tab. III. Fig. 2.*) some other convenient Material, which may be able to rise from the Bottom, after the Weight, that sunk it, is separated from it; this

Ball

Ball is marked in the Figure by A A ; this has a cylindrick Hole, B B B B, open quite through the Middle of it, that the Water may pass freely thro' it, as it descends to the Bottom ; in this I place two Plates, C C, C C, edge-wise, to the Passage of the Water, which have each a Center-Hole to receive ; and hold the Pivots of an Axis F F, so as to move freely therein : Upon this Axis are fastened 4 Vanes, in the Manner as I have formerly describ'd, for Measuring the Way of a Ship thro' the Sea ; these are marked with E E E ; this Axis has a Screw Pinion on it at G, which every Revolution turneth one Tooth of a Wheel of Account, H, whose Pinion turneth I, whose Pinion turneth K, &c. these keep a certain Account, how many Revolutions the Vanes do make, in their Passage to the Bottom ; and the Revolutions do measure the Body of Water, they have passed thro', in their whole Descent ; but that the Rising of the Ball may not cause the Vanes to return backwards, I have several Inventions ; that I shall mention, at present, is very easy, namely, a Lid, or Cover to the cylindrick Passage, which is shut so soon as ever the Weight leaves the Ball, which I effect by the Spring M, which is kept down close to the Ball, whilst it is descending, but springs up so soon as the Weight is left, it shutteth the Cover N, which stops the cylindrick Hole.



Dr. HOOK's Lecture, read Dec. 16. 1691.

IN my preceding Lectures, I have described two of my *Nuntii Inanimati*, or *Exploratores Abyssi*, whose Business it is to bring back a certain Account of the Distance, or Space, between the Top and the Bottom of the Sea, which I made Choice of, in the first Place, to equip, they being previous, and the Forerunners of all the rest. The first of these, tho' it would do well enough in moderate Depths, where there is no great Difference in the Temperature of the Water, as to Heat and Cold, and other Qualities; yet in greater, especially in very profound Depths, I conceive, it may be liable to Uncertainty, for the Causes I did the last Day mention; which to prevent, and obviate any other Cause of Doubt, which I could, or can yet think of, I did contrive the second *Explorer Distantiæ*, which I described the last Day; the Contrivance of which is such, as, I conceive, will most exactly measure the said Distance, and bring back the true Account thereof. The Way I mention'd, the last Day, was contrived only to measure the Length of its Descent; which, I conceive, will be sufficient Assurance of the Extent, or Depth, thereof. However, if any shall desire to be more ascertain'd of the Truth and Exactness thereof, I have contrived a Variation of, or Addition to, the same, which is only another Prismatick Box, or Hole, with the same Kind of Helical Vanes and Wheels of Account, as the former had, which is so adapted to the Float, and contrived, that, all the while the Weight is descending, this additional Way-wiser shall stand still; and so soon as ever the Float is freed from the Weight that sank it, and it begins to ascend, this
doth

doth then begin to move, and so continues, till it arrive at the Top of the Water: So that as the former did measure the Length descended, so this doth measure the same ascended; which if they be found to agree, 'twill be a double Confirmation of the Certainty of the Experiment. I know it will be objected, that this will make the *Apparatus* very chargeable and difficult; and (as seeming complicate) to be apt to be out of Order; and few will use the Caution and Circumspection, that such an Instrument will necessarily require: To which I answer, that I can make the whole so easy, and obvious, that the whole Instrument need not cost above a Crown; and that any one, almost, shall be able to make, or to mend it; and any one, that can but write and read, can be able to make Trial therewith, and keep Account thereof; nor will it easily be so out of Order, but that it may easily be mended, and set to Rights again. This, I conceive, will do; all that needs to be done, to perfect this Enquiry, which being the first, and principal, I have been the more curious, to obviate all Objections, and to reduce it to as easy and plain a Way, as can well be desired, considering the many Difficulties which are to be provided against. I have not made a Module of this third, and most compleat Contrivance of all the three; but I have prepared a Draught, so that those, who understood, and remember the Contrivances of the first and second, will easily comprehend the Fabrick of this.

The Third Explorator Distantiæ.

A A represents the Ball, or Float of Wood, through which is put B B, a Stick fixed on the Top of it, for the more notable Sign, or Signal, (by which to find it, in the Sea, after its Return) but bigger, and more substantial downwards, that it may be the more fit to hold the Staple, and Hook at the Bottom C C, and likewise the Cross-Piece E E, which passes through a Mortice made in it, and is thereby kept at Right-angles with it; upon the Ends of this Cross-piece, E E, are fixed two prismatick Boxes, F F, and G G; F F is the Box that holds the Vanes and Way-wiser, made after the same Manner, as was that of the second Module, which I shew'd the last Day, with no other Difference, but that in this Contrivance, the Box is shut by the Water, so soon as ever it begins to ascend, without any Need of the Spring which I had made in the second; and that the Box is made to open one Side, the better to fix the Vane and Way-wiser; and likewise the Inside of it is square, the better to be kept steady in the Water, so that it shall not be winded, or twisted by the Helical Vanes; which it would be more apt to be a little, if the Hollow of it were truly cylindrick. (*Table IV. Fig. 1.*) G G is exactly the same Kind of prismatick Box, with Vanes, and Way-wiser, as the former, but it is perfectly inverted, with respect to the former; for in the former, the Valve, or Lid to cover it, is placed, or fixed by Hinges, to the Top, so that the Water shuts it, and keeps it so, all the while it ascends. In this, G G the Valve, or Lid, is placed at the Bottom, and remains shut all the Way it descends; but so soon as it begins to ascend, 'tis opened, and the Vanes are turned by the Boxes passing through the Water.

Water. The Contrivance, for the opening and shutting these Lids, is by an equal Flat, fixed on the Axis of each, at Right-angles with them, that of the ascending Way-wiser, G G, is drawn, and marked with H H in the Figure. Thus, I conceive, I have sufficiently accoutred my first *Explorer*, who is to inform me of the Depth; and is, indeed, to be the General Post that must fetch me all the other Informations I desire.

The Thermometer, or Explorer Temperaturæ.

IN the next Place, I desire to be informed of the Temperature of those lower Regions, as to Heat and Cold: And for this Purpose I have contriv'd a Thermometer, that shall certainly inform me; this is nothing but a small Bolt-head, filled up with Spirit of Wine, to a convenient Height of the Stem, with a small Embolus and Valve; the Embolus is made so, as to be thrust down the Neck, as the Spirit of Wine shall be contracted by Cold; and the Valve is to let out the Spirit of Wine, when it is again expanded with Heat, in its Ascent; 'tis very plain, and easy to be apprehended, especially when that is viewed, which I have here provided: It may, possibly, be thought that the great Pressure, of the incumbent Body of Water, may contribute somewhat to the Contraction, or Shrinking, of the Spirit; but tho' I am inclin'd to think, that That will not cause any sensible Variation, yet, to try that, I shall shew a Means how it may be discovered; which Discovery, of it self, will be a Discovery very considerable, (*Tab. III. Fig. 4.*) because none of the Ways, that have hitherto been attempted, have proved effectual,

effectual, for the Condensation of any Fluid, by Pressure only, though there have been made many Experiments, by this Society, on Purpose for such a Discovery.

Explorator Gravitationis.

NEXT I desire to be informed, whether the Pressure of the Water do exactly keep the Proportion which I have assign'd it: And for this Purpose, the perforated Cone, described in the first *Explorator*, sent down, and brought back with the *Thermometer*, will give an Account thereof; for by the *Thermometer*, (*Table III. Fig. 1.*) we shall be informed, what is the Degree of Cold, and consequently we shall know, what Part of the Condensation of the Air, in the Cone, is due to that, and consequently what Part is to be ascribed to the Pressure; and by the Way-wiser, or third *Explorator*, we are assured of the Depth, and consequently we may know, whether those do answer to each other, according to the Theory, or Proposition assigned.

THIS I mention, to shew that no one of the Instruments, I have already described, or shall, for the future, explain, are useless, or superabundant; for that, before I leave this Subject, I shall shew for what peculiar Use each of them is principally designed, tho' many of them will not only serve for that one, but for the Assistance of many others; where they will be of as necessary a Use, in Concomitance with others, as they are singly necessary for that End, for which they were principally designed.

It may possibly be queried, why I make use of Spirit of Wine to fill my Thermometer, and not of Water, or other Liquor: To which I answer, That first I found so many Trials, which I purposely made, to perfect that Kind of Thermometers, (of which, I believe, I made the first that were made in *England*, from the Sight of a very small one, brought out of *Italy*, about 30 Years since, by the President) that this Spirit was the most sensible of any Liquor, I could then meet with, of the Degrees of Heat and Cold. And secondly, because this Liquor was capable of enduring the greatest Degree of Cold, I could give it, by the Means of Salt and Ice, and yet remain'd fluid, without Congelation, but did continue to shrink to the last. Now what the Temper of the Sea may be, at those vast Depths, whither this is design'd to be sent, no Man now living, or ever did live upon the Earth, hath experimentally known, (as I am, with good Reason, persuaded). But, by Conjectures, one may be induced to expect, that the Cold should be there very predominant, and, in Probability, such as would congeal, and turn to Ice, a Body of fresh Water. And 'tis, in Probability, one of the Causes that the Sea was made to abound with Salts, by the Divine Providence, who adapted every Thing to its proper Use and End; for 'tis very hard to suppose, that the Heat of the Sun should communicate so powerful an Influence from the Top, or Surface of the Sea, downwards; for the Parts of any uniform Fluid, that are warmer than the rest, are also lighter, and consequently will ascend upwards; but that the heated Particles, at the Top, should sink, or descend, 'tis not to be supposed. Again, that the Light, and, possibly, somewhat of the Heat of the Sun, may be communicated to the Bottom, if the Water be clear, 'tis not to be denied,

denied, but then it must be so small a Part, of what we see necessary, to keep fresh Water from freezing here above ; first, by reason of the Quantity reflected by the Superficies of the Water ; and secondly, by the Opacities, that must necessarily obstruct their Passage, thro' so vast a Thickness, that no Part, near the Poles of the Earth, can receive so little Benefit of these two Qualifications of the Sun, as these Parts must needs do. It seems therefore reasonable to me to suppose, that where there is such a Defect of Heat, Nature does supply a more copious Quantity of Salt, or some other such Body, as is able to resist Congelation, whether Saline or Metallick ; as Quicksilver, or such like, Time and Experiments may inform us : Which Experiments, how they may be made, I shall, the next Day, inform you, and furnish you with such Emissaries, as shall bring back a true Account of what Kind of Substance the Mass of the Sea is composed, at any assignable Depth, not only at the Bottom, but of any interjacent Part assigned, between the Top and Bottom.

Lecture read Dec. 23. 1691.

I HAVE, in my preceding Lectures, endeavoured to shew by what Methods, and by what Kind of Instruments, we may be experimentally ascertain'd of several desirable Informations, about the lower Regions of the Abyss, or Great Deep. As first, and principally, what the Depth of the Sea may be, in any Place we desire to measure it ; and this by several Instruments of differing Construction, and upon different Principles ; the last of which, I conceive, to be so compleat, and perfect, as to obviate any Objection that can be made

R against

against it; as particularly that which was objected the last Day, that if the Water should move upwards or downwards, (tho' such Kind of Motions cannot, with any Ground, or Probability, be imagin'd, or supposed, since the Bottom, or Ground, is a Bound to the Water below, and the Superficies, or Air, is a Bound to the Water above; so that unless there be a Vent one Way, that is downwards into, or out of the Earth, or upwards, into the Air, there can be no Reason given why there should be such a Motion) but it may be said, that there may be, in some Places, some such *Voragoes*, as Father *Kircher* imagines, in his *Mundus Subterraneus*; that is, such subterraneous Passages, as convey the Water of the Sea from one Place to another: of which Kind he tells us of many, tho', I doubt, it will be difficult to prove any one of them. I know, indeed, that Mr. *Hacluit* hath taken a Passage out of *Gerrardus Mercator's* General Map, which doth hint at some such Extravagancies; his Words are these:

‘ Touching the Description of the North Parts,
 ‘ I have taken the same out of the Voyage of
 ‘ *James Crogen*, of *Hartzeron Buske*, which al-
 ‘ ledgeth certain Conquests, of *Arthur*, King of
 ‘ *Britain*; and the most Part, and chiefest Things
 ‘ among the rest, he learned from a certain Priest,
 ‘ in the King of *Norway's* Court, in the Year
 ‘ 1364. this Priest was descended from them,
 ‘ which King *Arthur* had sent to inhabit these
 ‘ Islands; and he reported, that in the Year 1360,
 ‘ a certain *English* Friar, a *Franciscan*, and a
 ‘ Mathematician of *Oxford* (possibly he meant
 ‘ *Roger Bacon*, or some of his Disciples) who
 ‘ leaving them, and passing further, by his Magi-
 ‘ cal Art, described all those Places that he saw,
 ‘ and took the Height of them with his Astrolabe,
 ‘ according to the Form that I (*Gerrard Merca-*

tor) have set down in my Map, and as I have taken it out of the Account of the aforesaid *James Crogen*. He said, that those four Indraughts were drawn into an inward Gulf, or Whirlpool, with so great a Force, that the Ships, which once entered therein, could, by no Means, be driven back again, and that there is never so much Wind, in those Parts, as to drive a Corn-Mill.

Geraldus Cambrensis (who flourished in the Year 1210. under King *John*) in his Book of the Miracles of *Ireland*, hath certain Words altogether alike with these; viz. 'Not far from these Islands (namely the *Hebrides*, &c.) towards the North, there is a certain wonderful Whirlpool of the Sea, whereunto all the Waves of the Sea, from far, have their Course and Recourse, as it were, without a Stop; which (these conveying them into the secret Receptacles of Nature) are swallowed up, as it were, into a Bottomless Pit; and if it chance that any Ship do pass this Way, it is pushed, and drawn with such Violence of the Waves, that estoones, without Remedy, the Force of the Whirlpool devoureth the same.

'THE Philosophers describe four In-draughts of this Ocean Sea, in four opposite Quarters of the World; from whence many do conjecture, that as well the Flowing of the Sea, as the Blasts of the Wind, have their first Original.' Thus far is Mr. *Hacluit's* Quotation of *Mercator*. Mr. *Hacluit* adds, in the Margin [*There is a notable Whirlpool on the Coast of Norway, call'd Malestrom, about the Latitude 68.*] The best Account of this *Malestrom*, that I can learn, is, that it is a Circulation of the Water of the Sea, caused by some submarine Rocks. But Father *Kircher*, who is good at Fiction, has found a subterraneous Passage for it, into the End of the *Bottnick Gulf*,

and from thence another, into the *White Sea*, not far from *Archangel*. I grant such a Passage may be possible, but I should be glad to have it proved; or indeed, any one of those many, which *Kircher* has asserted, in his *Mundus Subterraneus*. So that if there be any such Place in the World, it is not yet found out, or proved: And therefore there is no great Cause of supposing many, or making that an Objection against my third *Explorer*, who will perform his Business, tho' that were actually so; that is, tho' the Motion of the Water were directly upwards, or directly downwards; and not only that, but it will also, over and above, tell you, what that Motion is. This is evident, by comparing the Ascent with the Descent, for half the Sum will be the true Depth, and half the Difference will be the Motion of the Water, whether upwards or downwards, which the Way-wisers will certainly inform you of. But this, I suppose will be needless; however, I was willing to remove the Stumbling-Block, tho' it was but a Straw.

Explorer Qualitatum.

TO proceed then, I shall next shew how to fetch a Quantity of Water from the Bottom, or from any intermediate Space, or Distance from the Top.

THIS I perform, by means of a Bucket, the same I have formerly here describ'd, and verified by Trials; or by another Contrivance not much unlike it, which I shall by and by describe. The former Contrivance will serve indifferently, both for fetching the Water from the Bottom, or from any intermediate Part; but for the intermediate Parts, there is an additional Contrivance, or In-

vention,

vention, for freeing the Float from the descending Weight, or Stone, after it hath been carried down a certain Number of Fathoms, which the following plain Contrivance will effectually perform, at any determined Distance, let it be 100, 500, 1000, 1200, 1500, 2000, or more Fathoms required, where there is first found to be Depth, sufficient for to make such Experiments, which is necessary to be first well assured of by the third *Explorer Distantiæ*; because, if the Depth be not sufficient, that is, if the Stone, or descending Weight, do touch the Bottom, before it hath descended the designed Number of Fathoms, it will detain the Float, and not dismiss the *Explorer*, to return with its Message. The Reason of which, you will presently apprehend, when I have describ'd the Invention for the Performance thereof; tho' yet, with a small additional Spring, it will serve for both Purposes. I make use of the third and last *Explorer* for this Purpose. I fit to it two Buckets of Wood, made, according to the Contrivance I have formerly describ'd*; these are fasten'd to the lower End of the Stick, which passeth thro' the Ball, or Float, as I shew'd the last Meeting, and the Buckets are set at Right-angles, to the Bar that carries the Way-wisers, or Mensurators, as appears in the Figure which I have here design'd, where A A represents the Ball, or Float; B B the Stick thrust thro' it; C C C C the Cross-Bar, for carrying the Way-wisers; D D. D D, the two Buckets, plac'd or fix'd by their Arms E E. E E, to the said Stick, at Right-angles to the Bar; C C. C C. F F. F F represent the Covers at the Top of each; and G G. G G, the Valves, or Shutters for the Bottom; (*Tab. II.*

* See the Description of these Buckets in Philosophical Transact. N^o 9 and 24.

Fig. 2.) These being within the Box, or Bucket, cannot be well expressed by Delineation, but are faintly design'd by prick'd Lines; and the Description and Modules, I formerly made, do make the Design sufficiently plain. These Valves, or Shutters do stand open and upright, all the Time that the Float descends, and the Water passeth freely through them, changing every Bucket's Length that the *Explorer* descends; but so soon as ever it begins to re-ascend, they are presently closed, and shut into them their whole Capacity, fill'd with the Water in which they then are. This being then understood, for fetching up the Water at the Bottom, how deep soever, there needs no other Contrivance than what I formerly describ'd; for so soon as the Weight doth touch the Bottom, the Float, and all its Furniture, is freed from it, and so is at Liberty to re-ascend, and carry back with it, what it was design'd to fetch. But for fetching up the Water from any intermediate Depth, (as at 100, 200, 500, 1000, 1500, &c. Fathoms below the Surface) I have invented an easy Expedient, which is to let go the Weight, that sinks the *Explorer*, at any Station of Depth design'd. I have already explained the *Way-wiser*, or *Mensurator* of the Depth descended; one of the Wheels of which doth keep Account of every hundred Fathom descended: Upon this Wheel I put on a springing round Plate, with a Hoop about the Edge of it, which hath one Notch in the Circumference, or Hoop; this Notch I can set against any Number of the Plate, in the same Nature as 'tis common for setting the Alarm of a Clock, to go off at a certain Time designed; which, to effect, I have contrived a very easy Expedient, which the third Figure doth represent. (*Table II. Fig. 3.*) Suppose then B B, to represent the lower End of the Stick that hath the *Way-wisers* and

and Buckets, in the End of which is fixed *C c*, which is a Staple made of a flat Iron Plate ; between the Sides of this is fastened, by a Pin *c*, the Hook *d e* by the End *d* of which, doth hang the Wire of the Weight ; this Hook is kept in this Posture, by a small Piece of Wood or Iron *f g* ; the End *f* is cut sloping, to answer the Slope of the End *e*, of the Hook *d*. Now so long as the End *g*, of the Trigger (as I may call it) is detain'd within the Hoop of the Wheel of Account *b b*, of the Way-wiser, so long is the Hook, *d e*, kept firm in the Posture it is here designed, and so retains, or holds the Float and Furniture fast to the descending Weight ; but so soon as the Way-wiser has measured the Number of Fathoms designed, and the Notch in the Hoop be brought to the Place, where the End of the Trigger *g* may slip out, the Hook has no longer any Power to hold fast to the descending Weight, but presently lets it go, and the Float returns, and the Buckets close, and bring back their Bellies full of the Water of that Part ; or the Temperature, if the *Thermometer* be hanged to the Stick ; or the Pressure, if the Cone, together also with the Degree of Gravitation.

I SHALL only add one more Enquiry to be resolved of at present, and that is to know, what Alteration so great a Condensation, or Compression, as must necessarily be caused at so great a Depth, will be produced in the Body of the Air, so condensed ; that is, since the Air is but about 7 or 800 Times, at most, lighter than Water, and that 2200 Fathoms Pressure will, according to our Theory, reduce it to as dense a Body ; whether, I say, this Condensation will not actually reduce the whole Body of the Air, so condensed, into perfect Water. This may be easily tried, by letting down, with the *Explorer*, a small Glass Bolt-head, filled with Air, with the Mouth of the

Stem, or Neck, turned downwards, and contracting the End of the same, by a Lamp, into a small Perforation, to let in the Water thereby under the Air, as it descends, and to let out the Water, if the Air do again expand, as it re-ascends. This is so easy to be apprehended, that I thought it needless to add any Delineation, for the further Explication thereof.

Observations of the Lake-Wetter in Swedeland, made in the Year 1688.

THERE being some Congruity between the following Observations, and that which Dr. Hook had said in his Lectures, about sounding the Sea, I find that he took the Opportunity to entertain the Society with the following curious Relations, by concluding his last Lecture with them. But who the Author of them was, I have not found.

W. DERHAM.

WHEREAS Olaus Magnus, and divers other Authors have related wonderful and unusual Matters concerning the *Lake-Wetter* in *Swedeland*, I thought it worth while, for enquiring, more particularly, concerning the Nature of it, and the Truth of the Relations, to visit the Place my self, one Summer, whilst I went to the *Medivian Acidulæ*; thereby to be informed, from the neighbouring Inhabitants, of good Repute, of what I should enquire, and of what I could not be able to observe my self. The Sum of which I have here comprised, that it may appear, both whatever is there more strange, and also that the Truth of Histories

may

may be distinguish'd from Fictions. Geographers have so well described the Lake, that 'twill be lost Labour to add to it. It extendeth from *Askerfund*, on the North, to *Jonekopen* towards the South, 14 *Swedish* Miles, each of which is six *English*, and ten of them make a Degree; its greatest Breadth three, in some Places only two such Miles. It divides *Gothland* in two Parts; that on the East is call'd *Ostrogothia*, that on the West, *Westrogothia*; near the Bound of it is a celebrated Mountain, *Abme*, or *Obme*, and near it the City *Wadstein*, and its Castle on the East Side; and opposite to it, on the West Side, is the old Town *Hio*; the Lake, by Reason of Mountains and Hills that encompass it, some with their Cliffs, others at some Distance, to the Spectators always appears depress'd, or sunk into the Earth. The Depth of it is very differing, but yet great, in some Places but fourscore Fathoms; but on the Side of *Ostrogothia*, and in some of *Westrogothia*, no Bottom can be found, at 300 Fathom deep. Of this I was assured, by an Experiment which *Mr. Ericus Simonius*, the Minister and *Præpositus* of *Wadstein*, a Person worthy of Honour and Credit, communicated to me (he, being by long Experience well informed concerning this Place, was highly assistant to me by his Information) he told me that not long since, one *Benedictus Amberri*, a Citizen of *Wadstein*, who founding the *Wetter*, near the Shoar of the City *Grennen*, with some hundred Fathoms of Line, hanging an Axe instead of a Weight to it; and upon pulling it up, he found his Axe lost, and, instead thereof, a Horse Head fast to the End of his Line, but could find no Bottom. Such another Abyss is near the Cliffs of the Mountain *Obme*, call'd the *West-Wall*, which has eluded the Industry of all that

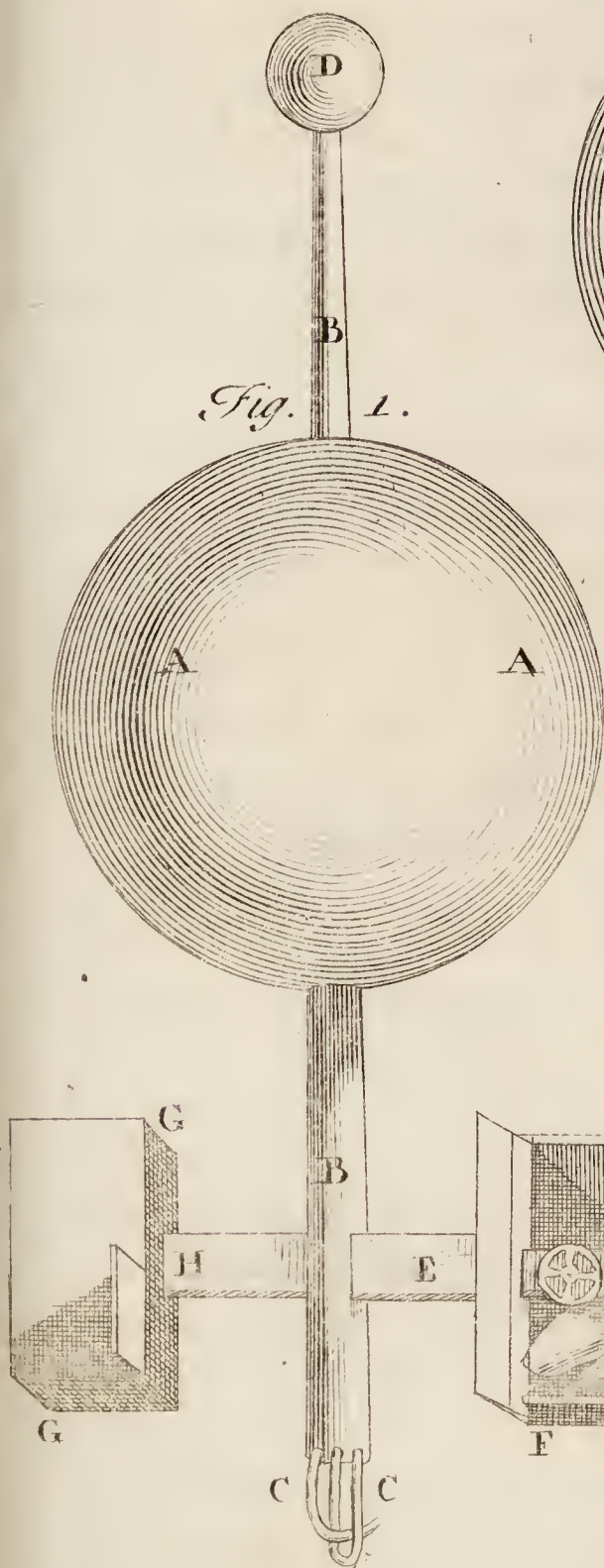
' that have sounded it ; whence none will approach
 ' that Part, for fear of a West Wind, which, ri-
 ' sing suddenly, would dash them against the
 ' Cliff, there being no Anchoring to hinder it.
 ' So also on the *Westrogothian* Side, the Gover-
 ' nor, Count *John Oxensterne*, desiring to sound
 ' the Depth with 300 Fathom of Line, could find
 ' no Bottom ; as the Fishermen, who made the
 ' Trials, and are yet alive, do testify. The Wa-
 ' ter is very clear, as well as deep, so that a small
 ' Piece of Money may be seen to a great Depth.
 ' Mr. *Ericus Simonius* has seen a small Piece of
 ' Silver, in a calm Day, 60 Cubits deep ; but the
 ' Water, at a greater Depth from the Superficies,
 ' seems tinged with a Kind of Green. And won-
 ' derful 'tis, that notwithstanding such Abundance
 ' of Filth is wash'd into it from the circumjacent
 ' Hills and Woods, yet the Water should not be
 ' sullied. Tho' this Lake exceeds most for Am-
 ' plitude, yet 'tis free from Rocks, and has few
 ' Islands ; the chief of which is *Visingsoe*, the Seat
 ' formerly of the Counts of *Brabe* : It lies in the
 ' Middle of the Water, between *Grennam* of *Smo-*
 ' *land*, and *Westrogothia* ; and on the North, op-
 ' posite to the *Acidulæ Medivienses*, lies the Island
 ' *Rocknens*. Some few other Islands, and those
 ' very small, lie near the Shores ; but the *Wetter*
 ' lying exposed to the Winds, and being encom-
 ' passed with Mountains, 'tis no Wonder that it
 ' lies seldom quiet, but is continually ruffled with
 ' Storms and copling Seas, which does sufficiently
 ' toss the Vessels on it ; and this oftentimes hap-
 ' pens so suddenly, and unexpected, that its Sur-
 ' face, being as smooth as a Looking-glass, becomes
 ' to be secretly moved, before any the least Breath
 ' of Air can be felt ; which seems to be caused by
 ' a Storm in some other Part of it, that communi-
 ' cates it under Water, before it can arrive above
 ' by

Table II.

Fig. 2.

Fig. 1.

Fig. 2.
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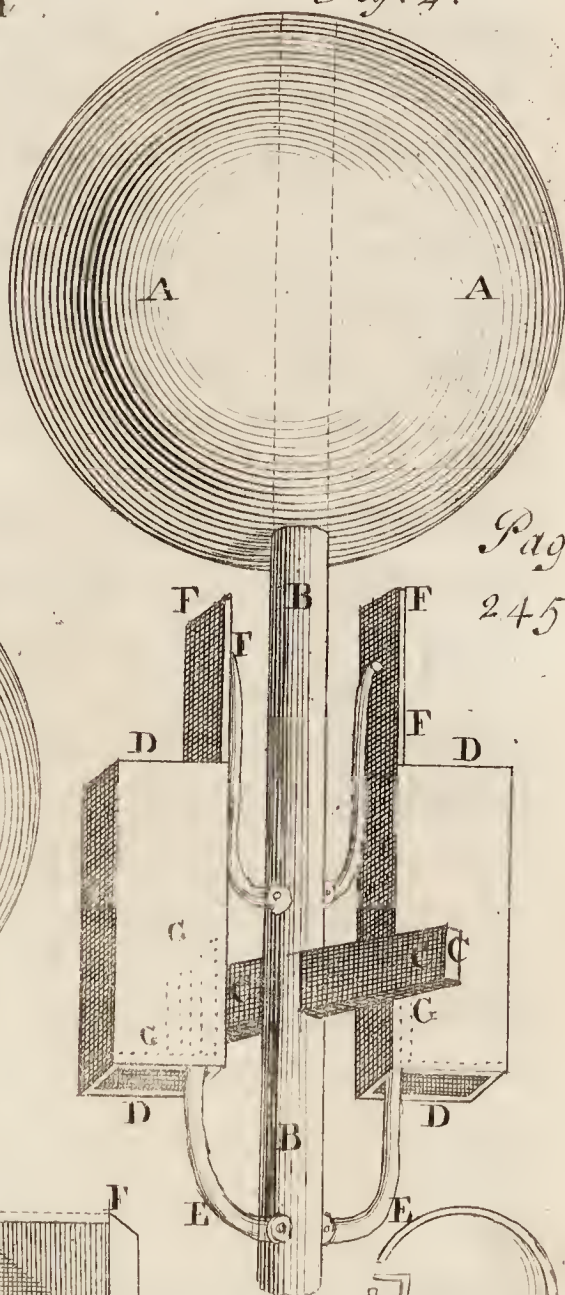
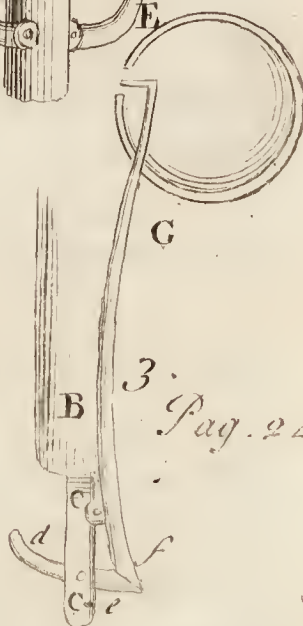


Fig. 3.

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to front. p. 250

by the Air ; for it often happens, in the *Wetter*, that Ships are ruffled, and driven with Storms in one Part, whilst others, hard by, are rowing and becalm'd ; which is a plain Sign that these are caused by the Eruption of subterraneous Winds, as *Varenius* explains them, in his *General Geography*. Divers Phænomena confirm this Suspicion : For, upon the approaching of a Storm, and Tempest of Rain, there is perceiv'd a Rumbling, or thundring Noise, of the Water, whilst the Air is yet serene and calm ; which happen'd to me also going to the *Acidulæ* ; for I heard that Thundring, whilst the Air was most calm ; but always a whirling Storm presently followed. This the Inhabitants of *Wisingsjöe* do more plainly know ; who, lying opposite to those Islands whence the Storm comes the next Day, do hear this thundring Noise, like the Discharge of Cannon. And when this Roaring is heard from the East, the East Wind rageth, with Hail and Rain. The sudden Huffing of Vapours, and Rising and Gathering of them together, which some have remarked in this Lake, are worthy Notice. Some such thing the Architect *Abraham Winandz* (passing these Coasts with his Company) observed, not without Admiration, that the Water being yet calm, there were darted out, as 'twere from the Bottom, certain small Clouds, which, coalescing together in the Air, infested the Travellers all Day with small Rain ; all which do conspire to prove these subterraneous Winds.

To the same Cause, without doubt, 'tis, that the Ice in the Spring is one Hour so thick and strong, as to bear Horses and Trahys, upon the Coming of a Storm ; the next Hour, those, that were securely carry'd in these Tra'ys on the Ice, may as safely navigate the Lake in Boats, the

Ice

‘ Ice so suddenly breaking and disappearing. But
 ‘ before such Kind of Ruptures happen, there
 ‘ is heard a Roaring of the Water, which,
 ‘ with Terror, warns the Travellers to fly off;
 ‘ though oftentimes such, as are far from the
 ‘ Shore, are either drowned presently, or, with
 ‘ great Difficulty, at last escape on Pieces of Ice.
 ‘ Sometimes also the Ice suddenly sinks, when the
 ‘ Air is not in the least moved. Now, whether
 ‘ metallick *Halitus*’s may contribute to the Rai-
 ‘ sing these subterraneous Winds, for the present,
 ‘ I shall not dispute: But that such are not there
 ‘ wanting, the divers Mountains that encompass
 ‘ the *Wetter* on the North, and the *Westrogothian*
 ‘ Shores, richly furnish’d with Iron Ore, and also
 ‘ with others more rich lately discover’d, and
 ‘ others also, as *Antimony*, *Magnesia*, *Mica Sterill*
 ‘ but shining, the Species of *Galæna*, *Ochre*, *Py-*
 ‘ *rites*, &c. whence have been extracted *Sulphur*,
 ‘ *Vitriol*, *Alum*, and other mineral Juices, do
 ‘ plainly prove. Nay, the Water affords great
 ‘ Quantity of *Pyrites*, and a Kind of Iron
 ‘ *Ochre*; divers Pieces of which I my self, for
 ‘ Curiosity, collected. To these also are to be
 ‘ ascribed the *Ignes fatui*, frequently observed not
 ‘ only upon the Shores; but, in the Night, up-
 ‘ on the Middle of the Lake, they fly to and fro,
 ‘ and confound the Fishermen; which are gene-
 ‘ rally ascribed to an Increase of metallick and
 ‘ sulphureous Vapours: Nor are the *Granates*,
 ‘ *Porphyries*, *Jaspers*, *Chrystals*, and divers other
 ‘ choice Stones, such as were heretofore collected
 ‘ by the Count *Peter Brake*, and by Art reduced
 ‘ to such Lustre as to be used for Marriage Jewels
 ‘ at *Wisingburg*, to be believed to be generated
 ‘ without mineral Steams: For, all these are the
 ‘ Off-spring of Minerals, as are also the *Acidulæ*
 ‘ *Medivienjes*, of which more another Time.

BUT

' B U T among many other strange Qualifications
 ' of our Lake, we must not pass over the won-
 ' drous submarine *Vortices*; and pertinacious Tor-
 ' rents, which cause great Trouble to the Fisher-
 ' men, when the Wind sets against the only Exit
 ' of this Lake; from which venting of Rivers
 ' and Winds from below, and its unfathomable
 ' Depth, 'tis believ'd that the *Wetter* has Com-
 ' munication, by subterraneous Passages, with
 ' another *Swedish* Lake, called the *Wenner*, about
 ' ten *Swedish* Miles distant: And the several *Vo-*
 ' *rages*, that are between these two, do seem to
 ' confirm the Conjecture; two of which lying in
 ' the Parish of *Fagren*, and called, the one the
 ' *black*, and the other the *white Vorago*, Mr. *Had-*
 ' *dorphius*, a celebrated Antiquary of *Sweden*, has
 ' endeavoured to sound, but found them of un-
 ' measurable Depth; he observ'd also an intestine
 ' Motion in them, as if they were in a Fermenta-
 ' tion. This Opinion also is augmented, by rea-
 ' son the Water of the *Wetter* is some Years aug-
 ' mented, and the next Years considerably dimi-
 ' nish'd. Mr. *Daniel Ridelius*, the Pastor of *Mo-*
 ' *talen*, has noted, that these last seven Years the
 ' Water of some Parts of the *Wetter* has so much
 ' wasted, that many Places were left bare which
 ' used to be cover'd with Water to carry Boats;
 ' whereas the Rains have been very plentiful all
 ' about in the Years 1680, 1682, 1684, 1685;
 ' but, in the Year 1686, towards Autumn, the
 ' Water began again to increase, and has conti-
 ' nued so to this present Year 1688; but whether
 ' our Lake does observe such Periods of seven
 ' Years in Increasing, and seven in Decreasing, as
 ' the *Wenner* is assertd to do, by those that have
 ' enquired, I cannot now positively assert. It is
 ' also wonderful, that in a calm Air the Guns of
 ' *Stockholm*, and other Places 30 Miles distant,

are plainly heard here: As, when in the Year 1685, the Princes were buried at *Stockholm*, every Shot was distinctly heard here at Five of the Clock: So also, the Broad-sides at the Sea-Fight in the Year 1676, at about 30 Miles Distance, were distinctly remarked. But what *Olaus Magnus*, *Messenius*, and other Historians, relate of the Cave of *Gilbert*, in the Island of *Wisingfoe*, I leave to their Credit: Only, this is true, there is a Cave, at present, that is fill'd with a Stench of Sulphur very odious, which, with the Consent of the Inhabitants, has been collected into a Cave near the Water of the Lake; which, by being long pent up, it eructates noxious and sulphureous Vapours, which others have ascribed to other Causes, which I cannot approve: And Antiquity has discover'd its Weakness, in so easily giving Credit to such Fables; tho' they relate stupendious Things of the said *Gilbert*, and his *Præceptor Catillus Runes*. But that there do appear divers *Spectra* and Phantoms in the neighbouring Parts in the Shape of Women, Horses, or other Animals, none that are intent about these Matters do gainsay. These might be evinced by Relations of modern, as well as antient Times; but, for the present, I omit them. But I must not omit the celebrated River *Motala* (the only Mouth of this Lake) which at certain Times seems at a Stay, and dried, so that one may go and take up the Fish that are left at the Bottom, without Impediment, as it happen'd in the Years 1682, and 1685, at *Christmas*. And the common Inhabitants believe, that this Stop of the Water never happens, but either Dearthness of Corn, War, or some other publick Calamity is portended by it; as much as the *English* believe the Coming of a Whale into the *Thames* is ominous.

nous. But, for my self, as a Naturalist, enquiring only the Causes of natural Effects, they were no ways satisfactory to me, unless I found them conformable to the known Laws of Nature: I was therefore more solicitous about those Things which were advantageous to this Purpose, for explaining this Phænomenon of the River, tho' I had not the Opportunity of seeing this Stopping: And tho' they divers Ways endeavour to solve the Phænomena, by saying, that at that Instant the Waters do recede from the Shores, and go to the Bottom; yet I always suspected, that the Ice, or Snow, did some ways obstruct the Passage of the Water above, whilst at the same Time the inward Water flowed out into the Sea. What hinted this Conjecture was, 1. That this Mutation never happened in the Spring, Summer, or Autumn, but always about *Christmas*, or in the Beginning of the Year. 2. That this only happen'd near the Bridge, where the Water is but three Ells deep, and the Heaps of Stone, on which the Bridge is founded, do impede its Course. And this Suspicion the Pastor of the Church of *Motalen*, who lives hard by the Bridge-Foot, does judge very rational, from his own and others Experience; for he has noted, that divers long Plants, such as *Potamogeton*, *Polygonum aquaticum*, &c. do grow in the Parts near the Bridge, and that by these the Ice and Snow will be clodded and bound together, which, being carried by the River to the Bridge-Foot, do in Time so accumulate against it, as to make an absolute Dam to the River. The Millers also that live there confess, that usually, before such a Stop, there are divers white Lumps flow out of the Lake, which sticking to the Bodies they meet with, like Glue, do by degrees sink there to the Bottom.

‘ Nor

‘ Nor is it unfrequent, that all the Water of the
 ‘ Lake shall be one Day quiet, and the next Day
 ‘ be stopped near the Bridge. Whatever it be,
 ‘ ’tis wondrous that this Retardation happens not
 ‘ in the sharpest Winters, but in a more mild Sea-
 ‘ son, and for the most part about *Christmas* or
 ‘ *New-Year’s-Tide*, when the Cold is yet intense
 ‘ under the Water, tho’ more mild in the Air;
 ‘ or, that the Ice, being less harden’d, is detain’d
 ‘ and implicated by the Weeds which cause these
 ‘ Obstructions. Before I leave this Subject, I
 ‘ cannot pass by the mentioning what I understood
 ‘ from the Reports of the ingenious Pastor of
 ‘ *Nijen*, (where the *Acidulæ Medivienses* are) and
 ‘ of divers others, concerning a certain Fountain
 ‘ not far from the Shore of the *Wetter*, in the Pa-
 ‘ rish of *Nijen* not far from the Church, and Pa-
 ‘ stor Mr. *Jonas Frodel’s* House; to wit, That
 ‘ they call this Fountain the *Foreteller of Dearth*;
 ‘ because it is never so fill’d with Water, as when
 ‘ a Dearth succeeds the next Year. ’Tis encom-
 ‘ passed round with soft sandy Hills, between
 ‘ which and the Fountain is a low Vale, but
 ‘ not marshy: Out of this, by occult Passages,
 ‘ issues this Fountain; singular in this, that in
 ‘ rainy Summers it waxeth dry, and in dry Sum-
 ‘ mers, when Famine is fear’d, or (by others whom
 ‘ I regard not) War, it overflows the King’s
 ‘ Highways of *Wodstein* and *Motala*, as is attested
 ‘ by many of the Inhabitants: Nor does it contra-
 ‘ dict this Report, this present dry Summer; for it
 ‘ abounds with Water, now all the neighbouring
 ‘ Fountains are dry’d up. And though this may
 ‘ seem fabulous or superstitious, yet ’tis confirm’d
 ‘ by many Experiments; which shews, that there
 ‘ are many internal Operations of Nature that yet
 ‘ are kept secret, and cover’d with a Veil, which
 ‘ we are yet unsufficient to discover. However, the

following Observations may somewhat assist: 1. That this Scarcity of Corn is foretold to *Ostrogothia* and the Places near the Fountain. 2. That in all this Region, and especially near the Fountain, the Plain is sandy, but in some Places it is thick Clay; which require much Water to make them useful. 3. That Corn is thin only in dry Years; the contrary of which happens in *Femtia* and other Northern Provinces. 4. That the Phænomena of Meteors are caused by subterraneous Influences for the most part. 5. That this Fountain is supply'd by straining through secret sandy Veins from these Sand-Hills. 6. That from some natural Causes, the Waters may ascend against a dry Season, and sink against a wet Season.

Dr. HOOK'S *Discourse concerning Telescopes and Microscopes; with a short Account of their Inventors, read in February 1691-2*

Of *Friar Bacon, Baptista Porta, Diggs, Metius, Galileo, and other Inventors of Telescopes.*

How much the great Improvements of natural Knowledge have been owing to the Discoveries and Improvements that have been made in Opticks, I think few can be ignorant of, that have inquired into the Reasons and Grounds of the Progresses made in this last Century, since it hath been actually effected: For, though it be evident that *Roger Bacon* did understand somewhat of the Grounds of it, and, in Probability, would have further improv'd that his Knowledge, if he had met with a Generation worthy thereof; yet such was the ill Treatment he receiv'd by false

Accusations, scandalous Reports, Imprisonment, and Loss of Places, that we hear no more concerning it, but only some Hints that he gave, of his being able to see things at a Distance as if they were near, in his Apology for himself, addressed to the then Pope, to protect him against his Persecutors. This Persecution quash'd it for that Time; and we find nothing of the Revival thereof, till the *Lyncean* Academy became founded in *Italy*; where, from the Encouragement that divers ingenious Men received, it was again started: And we find that *Johannes Baptista Porta* had made a Discovery of it, as is very plain by some Passages of his natural Magick; and our *Diggs* had done the same thing here, as is testified by his Son, who printed some of his Father's Works after his Death. These two Testimonies we have, that somewhat like the Telescope was known in the preceding Century, both the said Books being printed before the Beginning of this Century. We find nothing further concerning its Description, or Use, besides the Hint that it was then known to these two Men, some Years before *Galileo* put it in Practice. In the Beginning of the present 17th Century, *Metius*, a Spectacle-maker in *Holland*, light upon a Composition of a Convex, with a concave Glass set at due Distance in a Tube, which made a perspective Glass to see Objects at a Distance. And *Galileo*, in *Italy*, whether excited by a Hint thence received, or from *Baptista Porta*, or by his own good Genius, is uncertain, did the same thing at *Florence*: But not contented with the bare Invention, and Use for terrestrial Objects, he improved it farther, and made Use thereof for Discoveries of the Cœlestial Bodies. By this Means he detected the *Galaxia* to be an infinite Congeries of small Stars; as also the cloudy Stars, to be of a like Composition.

By

By the same he discovered the Roughness and Inequality of the Surface of the *Moon*, and the Phænomena of the Shadows and Lights of those rough and uneven Parts, and the Progress and Recess of the Light of the *Sun* thereupon. By this he discovered the four Stars about *Jupiter*, and in some Sort adjusted their Periods, and hinted the Use of them, for the Discovery of the Longitude of Places upon the Earth. By this also he discover'd the unusual Figure of the Body of *Saturn*, the Waxing and Waning of the Light of *Venus*, and the Spots in the Face of the *Sun*, together with their Motions and Changes; which last, whether it were not primarily, or at least at the same Time, detected by *Scheiner*, is disputable, since both lay Claim to it. This, I think, may truly be said for *Scheiner*, that whoever first detected them, he was the Man that perfected the Theory of them, so far as it has hitherto gone; which he hath performed in that most elaborate Work of his *Rosa Ursina*.

THESE Discourses excited the Curious of those Times to inquire into and improve the Knowledge of Opticks, especially that Part of it which had been least cultivated, namely, the Business of Refractions. (*Stelliola*, who was a *Lyncean*, seems to have been the first that discover'd the Ground of Refraction, in his Book *Il Telescopio overo il Specillo Celeste*.) *Kepler*, in his Opticks, explain'd the Reason of the Phænomena of *Senses*, and the Causes thereof; and also, that the spherical Surface did not give the true Figure requisite to refract all the parallel Rays that fell upon it to one Point, but a Figure somewhat elliptical; but made no Demonstration what the true Figure was, nor the true Proportion of Refraction. But *Descartes*, by these two Helps, went through with the Demonstration, and proved both the true ellipti-

cal Figure, and also most ingeniously and mechanically explain'd the Ground and Cause of Refraction

FERMAT soon after, taking a contrary Supposition, explain'd the same Phænomena; as did also *Emanuel Maignan*, in his *Perspectiva Horaria*, by a third Supposition; and our Countryman Mr. *Hobbs* by a fourth; but these two last by Ways less intelligible and more improbable. Others since have gone other Ways, but fall short of the first. However, the first Successes caused it to be exceedingly cultivated by very many ingenious Men. And that not only as to the Theory, but as to the Practice also: Thence many Attempts have been made by divers ingenious Men, as *Descartes*, *Hevelius*, Sir *Paul Neile*, *Divini*, Mr. *Smeibwick*, and others, to make Object-Glasses and Eye-Glasses of elliptical Figures, but all without Success. However, of the spherical Figure they made good Improvements, by making Object-Glasses of much greater Lengths, and truer Figures, than they were at first able to do: For, *Galileo's* Glass, of which he made so good Use, I have been informed, was not above four or five Foot long, at the most; and, I am apt to think, that the Glass, *Hevelius* used for his *Selenography*, was not better, if, at most, it were so good; since as many Particulars, as he has noted in that Book, may be made with a Glass of three Foot. But Sir *Paul Neile* made some of 36 Foot pretty good, and one of 50, as I have been informed, but not answerable. *Divini* and *Campani* made also Glasses of those Lengths, but how good I cannot knowingly affirm: However, if we may be allowed to judge of them by the Discoveries they made with them of the true Figure of *Saturn*, I conceive they were but ordinary, and did not exceed our 12 or 15 Foot Telescopes; for, by one of that Length, I plain-

plainly discover'd the Ring and Satellite of *Saturn*, to be as Monsieur *Hugenius* doth assert in his Book; and, with the same Telescope, I first discovered the permanent Spot in the Belt of *Jupiter*, which proved its diurnal Motion on its Axis. Since that, Mr. *Reize* first, and then Mr. *Cox*, made some good Glasses of 50 and 60 Foot long, and the last one of 100; but how good, I cannot assert, having not made Trial of it. And, as it hath been cultivated here, so others, in *France* and *Italy*, have not been idle: Particularly one Mr. *Borelli*, at *Paris*, who presented one of a considerable Length, to this Society, which Mr. *Flamsteed*, I suppose, has in his Keeping, Sir *Jon. Moor* having borrowed it of the Society for his Use. But tho' there has been some Life left in the Grinders of Glasses, yet the Warmth of those, that should have used them, has grown cool; and little of new Discoveries hath been made by them, besides what Mr. *Cassini* has done at *Paris*, in discovering four new Satellites about *Saturn*, besides that of Mr. *Zulichem*.

MUCH the same has been the Fate of Microscopes, as to their Invention, Improvements, Use, Neglect and Slighting, which are now reduced almost to a single Votary, which is Mr. *Leeuwenhoek*; besides whom, I hear of none that make any other Use of that Instrument, but for Diversion and Pastime, and that by reason it is become a portable Instrument, and easy to be carried in one's Pocket.

IF we enquire into the Reason of this Change of Humour, in Men of Learning, in so short a Time, we shall find that most of those, who formerly promoted these Enquiries, are gone off the Stage; and with the present Generation of Men the Opinion prevails, that the Subjects to be enquired into are exhausted, and no more is to be

done: Besides, they pretend that all the Discoveries that have been hitherto, or that can be made, for the future, by these Instruments will afford no gainful Profit, and all other Notions are insipid with them, besides such as bring ready Money.

BUT those, who make such Estimates, may, perhaps, find themselves very much mistaken in their Judgment, if the Subjects were duly prosecuted, as they are capable of so being. For, as to the Discoveries that may be made in both Kinds, I conceive they are vastly greater, both for Number and Value, than those few that have been already made; and not only for the Information of the Intellect, but what answers their greatest Objection, even for the increasing their Treasure.

HAVING given this short Account of the History of Telescopes, as also of the Use and Discoveries that have been hitherto made with them, which, as they have been very considerable, as to the Improvement of the physical or natural Knowledge of the Cœlestial Phænomena, I may observe that a further Improvement and Use of them, will, in all Probability, afford much greater, and more considerable, not only for the perfecting and completing the Knowledge of those Particulars which have been already, in Part, detected; but also for making of other new Discoveries, which as they are yet much further removed from the Power of the Senses to comprehend, so they have been, upon that Account, never afforded Entrance into the Imagination and Intellect; if at least *Aristotle's* Maxim be true, That there is nothing in the Intellect, but what was first in the Sense: And tho' there are many Things that may be imagined, and guessed at, by Analogy, and the Uniformity of the Proceedings and Productions of Nature; yet there are certain Non-pareils of Nature, of which Kind, possibly, nothing like them have been produced in
all

all those Particulars, which are more common and obvious, as I might instance in the Body of *Saturn*. For who would ever have imagined such a Configuration or Fabrick, as that of the Ring of *Saturn*? what is there in all the other Celestial Bodies, we yet know, that is analogous to it? and from the Imperfection of the first Telescopes, what extravagant and irrational Conceptions were formed thereof, as does more evidently appear, by the Descriptions and Explications of the Phænomena of it, before the more perfect Discovery made by *Monf. Chr. Huygens*, and his ingenious Explications thereupon. And that *Autopsia* is not only useful, but absolutely necessary, to give one a true *Idea* and Conception of many Phænomena, without which, the Imagination is very apt to rove, and go out of the true Way, as I might confirm by many Instances, there being enough; but I shall only mention one, namely, that of *Dr. Vossius*, his Explication of the Phænomena of the Moon, published in his last Book, upon which I did formerly read a Lecture to this Society, to shew the Irrationality thereof, and how little Ground or Probability there was to be found in all the Phænomena of that Planet, viewed and examined with a good Telescope. And therefore I did conclude, that that learned Man did never, himself, observe the Phænomena, or if he ever did, it was certainly with a very small, and very imperfect, Telescope. Upon which Account, *Autopsia* is not only necessary for directing the Mind and Intellect, in its Progress to be made, for what is to be gone thro' with; but 'tis necessary also, for the reducing it to its right Way, from which it may have been misguided, by the false and erroneous Suggestions it hath formerly met with, either in some famous Authors that have positively asserted, or defended a Falsity; or of some other

Person reputed eminently skilful in this, or that Part of Knowledge. With which Kind of Information, how full are the Authors that have treated of some Subjects? and that not one or two, but Hundreds, nay, Thousands, if we consider natural Philosophy and Physick, with the Arts subservient thereunto: What shall we say to the whole Generation of Astrologers, which have yet always prevailed, and possibly always will, with some especially, who have once been prepossessed or prejudiced for it: The like may be said of those who defend the four *Aristotelian Elements*, or the four *Chymical Principles*, or the three *Cartesian Materia's*, or his *Mundane Vortices*, which are, in Probability, all alike *Chimera's* which have sprung up, and got rooting in the Minds of Men, in several Ages of the World; and having once prevailed, they become prolifick, and propagate themselves in new Soils, and new Assertors and Defenders of those Doctrines do daily spring up: Among these may also be ranged the *Solid Orb Men*, the *Plastick Faculty Men*, and the *Sympathy* and *Antipathy Men*, each of which, having once embraced their respective Doctrines, will maintain and defend them to the last, against all others whatsoever. 'Twas from the first of these Sects (as I may call them, from their Division from the true Philosophy) namely, the *Solid Orb Men*, that poor *Galileo* was put into the Inquisition, and, to save his Life, was necessitated to lose his Doctrine, and to unsay what he really knew, and had discovered and asserted; and tho' he, as well as *Copernicus*, was encouraged, at the first, by Popes, Cardinals, and Princes, yet in the Conclusion all fail'd, and their Doctrine must be condemn'd. Thus it happen'd also to *Roger Bacon*, and, I am apt to suspect, to the far greater Man, the Lord Chancellor *Bacon*, for being too prying into the then receiv'd

ceiv'd Philosophy: But notwithstanding all this, there is a real Beauty and Allurement in Truth, that will produce some Votaries in the worst of Times; and that will in Time prevail, and shine out, and dispel the Clouds of Error that encompass it. *Multi transibunt & augebitur Scientia*, was the prophetick Saying of *Daniel*, and used by the learned *Verulam*. And there is no doubt, but there is yet behind, much more to be discovered, than what is already known, if fit Methods, and fit Instruments be apply'd, and prosecuted with Diligence. Some Uses I have made of the *Telescope*, and not without some considerable Success; as in the Discovery of the Figure, Motions and Qualities of the *Cometical* Bodies; as namely, of following them for near a Month after they disappeared, and finding them retrograde, in observing their flame-like Figures and Qualifications; in discovering the Smallness, or rather Inconsiderableness of their Parallax, by a Way not taken notice of before, by any that I know of: And tho' *Monf. Cassini* has described it in his Observation of the Comet in 1680, yet he hath added nothing more to it, than what I published in my *Cometa* some Years before, save the Application of it to that Comet. By these I discovered the Parallax of the Earth's Orb, and the Visibility of the fix'd Stars, at all Times of the Day. Upon which Occasion I cannot but take Notice of a Passage printed Page the 385th of *Ozenam's* Mathematick Dictionary, and, by him, said to be written by *Monf. Cassini*; the Sense is this; By the Means of great Telescopes, fixed to certain Parts of the Heavens, thro' which the fix'd Stars pass, which are the most proper for this Observation, one may best examine whether there be any Difference (of the Situation of those Stars, as to *Parallax*) in different Seasons of the Year; for this Design, in the Foundation
of

of the Royal Observatory, there is left an Opening thro' all the Vaults, by Means whereof one may see, from the Bottom of the Vaults, the Vertical Stars, thro' Telescope Glasses of 160 Foot in Length, which will be prepared against the Observatory is finished. Notwithstanding the *English* Astronomers have begun to practise a Method like to this, we are assured, by an Essay of Observations which they have made with great Subtilty, that they have found some such Difference, which have verified that the Diameter of the annual Orb of the Earth hath some sensible Proportion, compared to the Distance of the fix'd Stars; which, nevertheless, is not yet evident to us, by reason that the Observations, we have made of some fix'd Stars Variations, do not agree with this Hypothesis; for that the Variation was not found in the Way that this Hypothesis requires: But if the Observations should confirm it, and be correspondent to the Hypothesis, yet then we may doubt, whether the Variation be from this Cause, or from some constant Variation of some fix'd Stars, which hath no Relation to the Earth's Motion; I suppose, he here means *Mallement de Mesang*, who, to evade the Strength of the Argument for the Earth's Motion, drawn from the sensible Parallax amongst the fix'd Stars, assigns every fix'd Star to move in a small *Epicycle* that will answer the Appearance. (Observe only the Humour and Ingenuity of these great Philosophers and Astronomers, and judge how likely 'tis, by any Means in the World, to convince such of any Error they shall once assert.) Yet, be pleas'd to observe his Conclusion; *viz.* But when we have found, by a great Number of Observations, that a sufficient Number of the fixed Stars have a Variation conformable to this Hypothesis, then we may judge that there is some Foundation for it, notwithstanding some Irregularity

larity that has been, in Part, observed to the contrary. The Observation is extremely difficult and long, because the Period of the Variation, propos'd to be observ'd, is of a whole Year, and requires that the Instrument shall be unshakeable. It is for this, that it can no where be better done, than in the Royal Observatory. Thus far *Monf. Cassini*. To which *Mr. Ozenam* adds, [That the Royal Observatory is a haughty Building, which the King has caused to be built in an eminent Place, without the Suburbs of *St. James's*, for making Physical and Astronomical Observations; and that it is called Royal, for that it was built by the Munificence of *Louis le Grand*, whose Liberality has extended to divers Persons, distinguished for their Merit, and principally to a certain Number of learned Men, chosen out of the rest, who have endeavoured, with *Eclat*, to make Sciences flourish in this Kingdom, who compose the Academy Royal of Sciences.] When my Attempt first was published, I was informed some of that Assembly were angry at it, for that it had not been first thought of by them; but I confess I did not believe it. But meeting with this Passage does seem to make it probable enough. However, they needed not have regretted it, since there were enough besides, as considerable to have shewn their Penetrancy of Spirit, and Accurateness of Observation; and tho' *England* possibly wants those Assistants which they can boast, yet I hope to shew, that weaker Means may effect many Things that their more powerful have fail'd to perform, if God grant me Life and Health.

IF we consider, in the next Place, the Fate of Microscopes, we shall find much the like to have attended their Performances. The first notable Thing performed by it, that I have met with, was the Figure of the Bee made by Sir *Francisco Stelluti*,

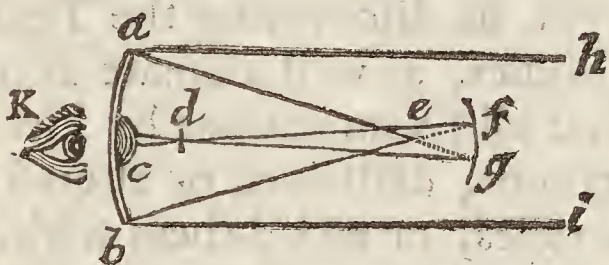
Stelluti, a *Lyncean*, and presented to Pope *Urban VIII*, which is mention'd by *Johannes Faber*, in *Historia Plantarum & Animalium Mexicanorum*, lib. i. p. 757. *Tam mirabilem anatonem præbuit partium omnium externarum, quæ in Ape sunt minuto animalculo, oculorum, inquam, linguæ, cornuum, jubæ, aculei, pedis, digitorum, aliarumque, & nuper in æs incidi commisit, atque felicitati Urbani VIII dedicavit, ut hæc omnia malim te oculis tuis intueri quam rudi meo calamo adumbrare.* And *Fabius Columna*, upon the same Place, says, it was *Impressum a Lynceorum Academia S. D. N. Papæ Urbano VIII in perpetuæ devotionis symbolum oblatum fuit anno 1625. Cum nostratis Apis imagine accuratissime a D. Francisco Stelluto novo quodam Microscopio observata, ut qui illam viderit in admirationem incidat; tam multas partes organaque depicta discernit, quæ ab intuentium oculis in ipso animalculo omnino absconduntur.* These Discoveries were also highly favour'd and practis'd by Prince *Cesius* himself, which greatly encouraged Observers, and produced many in divers Parts of *Italy*. Accordingly we find some Observations made by *Hodierna*, in *Sicilia*, about 1640, and others recorded by *Panarolla* about the Year 1650, namely, the Porousness of Man's Hair, the red Sands in Urine of calculous Persons, and the Worms in Vinegar. Many others were also found to make some few Observations in other Countries; but, by Degrees, it is become almost out of Use and Repute: So that Mr. *Leeuwenhoek* seems to be the principal Person left that cultivates those Enquiries. Which is not for Want of considerable Materials to be discover'd, but for Want of the inquisitive Genius of the present Age.

Dr. HOOK'S *Invention of a Reflecting Telescope:*

WHICH I insert after the foregoing Papers, by Reason of its Congruity therewith; because I know not the Time when this Telescope was invented, whether before, or after Mr. Cassegrain's, in Phil. Transf. N. 83. from which it differs in some very material Matters.

W. DERHAM.

I HAVE lately made a Telescope by Reflection, with which I look directly at the Object, and see it very distinct, and magnified. And this is by Planting a small *Lens* in the Middle of the *Object Speculum*, and Planting another small *Concave Speculum*, beyond the Focus of the *Object Speculum*; the Manner of which your Lordship will readily understand by the annexed Scheme; where *ab* represents the *Object Specu-*



lum, *e* the Focus of that Speculum, *fg* a small concave Speculum, serving to reflect the Rays to a second Focus *d*, where the Eye *k* sees the Object by the Help of the small *Lens c*. 'Tis easy so to contrive the Cell for the Eye, that the Rays that pass on each side of *fg* shall not disturb Vision.

WE long much to hear of Mons. *Hugenius's* Opticks and Mechanicks: They are Subjects capable of vast Improvements, and cannot be rationally expected from any more likely, than from
his

his acute Wit and excellent Pen. But, my Lord, I fear I have too far trespass'd upon your Lordship's Patience, and must humbly therefore beg your Lordship's Pardon, and subscribe my self,

My LORD,

Your Lordship's most Faithful

and most Humble Servant,

R. HOOK.

Mr. WALLER's Observations upon Dr. HOOK's Discourses, concerning Telescopes and Microscopes.

NOVEMBER the 29th 1693, Dr. Hook read a Discourse concerning Microscopes, their Uses and Advantages in discovering the Textures and Motions of Bodies, as well animate as inanimate; observing, that all Examinations by Fire, or Chymical Menstruums, destroyed or altered the compounding Particles, or mix'd them with, and confounded them with heterogeneous Parts of the Fire, or Menstruum, made Use of; whereas the Microscope discovers them in their natural State and Actions. Observing farther, that the Motions of the Viscera and of the Fluids, in the small Vessels, are, by that Instrument, to be seen, by their different Colours and Refractions, through the transparent Skins and Bodies of many Insects: Natural History, hitherto, being for the most Part only conversant about the outward Shape and Colour of Plants, Animals, and the like; but the Microscope would afford a very large Field of Enquiries

quiries and Obſervations, not yet much cultivated, which he recommends as one of the moſt proper Ways of diſcovering the true Texture and Mechanifm of Bodies.

In the next Place, he takes Notice of a Treatiſe lately publiſh'd by Sig. *Bonani* in *Latin*, call'd *Micrographia Curioſa*, &c. in which the Author deſcribes the ſeveral Sorts o Microſcopes, and gives his Way of Grinding Glaſſes for that Purpoſe in a Cypher, which Dr. *Hook* thus decyphers. The Tools are to be made of Braſs or Tin, and of a due Form; that the Diſh ought to be three times as large as the Glaſs that is to be ground in it; that the Diſh is to be held in the Left Hand, and the Glaſs in the Right, and ſo wrought and turned every way, one to the other, till the Glaſs has acquired its due Figure; that the Glaſs ought firſt to be ground near the Figure deſired, in a larger, and then finiſh'd in a ſmaller Diſh or Tool. And, for its Polishing, *Bonani* prefers the Way of gluing a fine Paper into the Diſh in which it was laſt ground, and by ſpreading on the Paper fine Powder of *Tripoli*; work the Glaſs therein till it has acquir'd its due Polish: And for this he recommends a Mandril to fix the Diſh on, made to run ſwift round, by Means of a large Wheel. Nevertheless, Dr. *Hook* approves better the Ways uſed by our Artiſts by a reciprocating Motion, and judges the bare Tool, without Paper, better for Object-Glaſſes, at leaſt of Telescopes; tho' for Eye-Glaſſes he grants the Way by Paper and *Tripoli*, ſufficiently exact.

He concludes this Diſcourſe with the Deſcription of Stings or Thorns of the Prickly Pear, or *Indian Fig*, thus; The brown Tufts on the Prickly Pear conſiſt of a great Number of very ſmall and ſharp-pointed Thorns, ſmaller than the fineſt Needle, and ſtiff, ſo that they eaſily pierce the Skin
of



of whoever touches them; and what makes them yet more troublesome is, their being all barbed with Thorns like a Bramble, or rather a Bee's Sting, so that they cannot easily be got out, when they are once enter'd into the Skin. Of this he gives a Microscopical Figure.

THE 6th of *December* following he read a Discourse of Telescopes, in which he observes, that *Galileo* first discover'd the small Stars, not visible to the naked Eye, in the cloudy Stars, and the Galaxy, which *Aristotle* asserted to be a Vapour, with the Figures of the Planets, at first, indeed, not exactly true, as to some of them, with their different Magnitudes, their Revolutions on their Axes, the Satellites of *Jupiter*, &c. He supposes that *Reita* was the first that made Use of Convex Eye-Glasses, taking in a larger Area than the Concave ones used before; and that he invented the Rete, or Mensurator, placed in the common Focus of the Glasses; which Sir *Christopher Wren* perfected, and invented the angular Instrument, consisting of two Telescopes joined at a moveable Joint, so as to take Angles by two Observers, to a Quadrant; and that himself had improved and recommended the Use of Telescope Sights for Astronomical Instruments, in his Animadversions on *Hevelius's Machina Cœlestis*. He proceeds to an Account of the Discoveries made by several learned Men, as the true Figure of *Saturn*, and of its Satellite, by *Monf. Huygens*; the Satellites of *Jupiter* by *Mr. Lawrence Rook*; four other

other Moons about *Saturn*; by *Cassini*, with the Periods of *Jupiter's* Satellites more exactly limited by the same. Next, he mentions his own Telescopical Observations of the Comet in 1664, and 1665: those of the Stars in the *Pleiades*, being 80, great and small, which Observations and Figure of them, in his Micrography, he here asserts to be very exact, and made with great Care; tho' Mr. *Cassini* and *De la Hire* have publish'd Figures of them very different from his, both as to their Number and Situation; whence he infers there has been an Alteration in that Asterism, as, he says, Mr. *De la Hire* also believes, he having found them differing from what he had himself at first observ'd.

Dr. Hook's Lecture here mentioned, being long, and Mr. Waller having extracted every thing in it observable, at least it being contain'd in the preceding Paper, I have therefore chosen to publish Mr. Waller's Extract.

W. DERHAM.

An Account of an Earthquake at Deal, and other Places in Kent, Portsmouth, on Sept. 8. 1692.

Deal, September 9. 1692.

YESTERDAY the People of this Place and Country were under a great Consternation, occasion'd by an Earthquake, which began precisely at two of the Clock in the Afternoon, and continued about six Minutes; during which Time the
T Houses

Houses shook; Pewter, Brasses, and other Kitchen-Goods, totter'd from the Shelves; empty Glass-Bottles, where they lay, dash'd one against another; Beds and Tables in the Houses shook so much, that People could not, for that Time, write; Some Chimnies fell, and several Houses shaken. This was at *Canterbury, Sandwich*, and many Villages thereabouts, tho' not so violent, yet we had the same at *Deal*, particularly at *Deal-Castle*; altho' the Wall thereof be of a vast Thickness and Strength, yet it shook so much, that the Inhabitants thereof thought it would have fallen on their Heads. In *Deal Town* several Houses shook, and so all the Country over; some Houses ready to tumble down, others safe, and felt nothing. In this, several Chimnies fell, and some Houses much damnified.

Portsmouth, Sept. 9. 1692.

HERE fell much Rain Yesterday, and between two and three in the Afternoon this Town and Point, for about three Minutes, had a very sensible Touch of an Earthquake, to the great Terror and Affrightment of many. The Tower of the Church, with many Houses, were found to shake considerably; but, blessed be God, I heard not of the least Damage, nor any thing more felt thereof since.



Fig: 1.



Fig: II.



Fig. III.

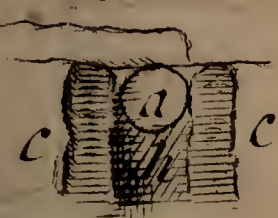


Fig. III.



Place this at Page 275 .

A Contrivance which Sir Robert Southwell saw at Brandenburg, for speedy Conveyance of Earth, and to fill up, or raise Ground, &c. communicated to Dr. Hook, Sept. 9. 1692.

The Explanation of the Figures.

FIGURE I.

- a.* The Basket to be filled.
- b.* The Basket emptying itself, by the lower Part of it hitting against the Axis of the two Pullies, *b.*
- c.* The filled Basket passing from *a* to *b*, supported by the Pullies, *n.*
- d.* The empty Baskets returning without any Support between the Extremes.
- e. e. e.* The Rope carrying the filled Baskets.
- f. f. f.* The same Rope returning them empty.
- g.* The Pulley at the filling End, supported by the Post *m.*
- h.* The Pulley at the emptying End, supported by the Post *k*, and turn'd by the Windle *i.*
- l.* The Post to support the interposed Truckles *n.*

FIGURE II.

- b. b.* The two Pullies fasten'd on.
- r. r.* An Iron Axis to be turned by
- i. q.* A Winch, or Windle.
- e. e.* The Rope, lying in its tapering Edge, as express'd in *Fig. III.*
- o. o.* The Basket hung by its Handles.
- p. p.* A Stick tied with Packthread, or girt on the Rope *e. e. e. e.*

FIGURE III.

g. g. The Shape of the Edge of the Pulley, express'd in the first *Fig.* by *b*, which is grooved with a tapering Groove, that may hold the Rope, on which is tied *e*, the Stick thrust thro' the Handle *f. f.* of the Basket.

FIGURE IV.

- a.* The Rope on which is tied
- b.* The Stick, thrust through the Handles of the Basket.
- c. c.* The Truckles Edge, hollowed with a half round *b*, for the Rope to run on.

A small Module would express all the Particulars, much plainer than any Draught. By this Way 'tis easy to transport Earth, Sand, &c. 1, 2, 3, 4, or 500 Yards, whether ascending, or descending; and, I conceive, two Men can do more than six in the common Way.



*Transcript of a Paper of a Quantity of Gold
up the River Gambay, in 1693.*

YOUR Importunity, together with my Gratitude to you, for your most curious Informations and Instructions in the Mechanics (without which, I confess my Labour had been in vain) has extorted that from me, which, I confess, the Resolution I had a-new taken to the contrary, by resolving never to divulge, either for Love, or Force; to which End I expect, according to your faithful and solemn Vows of Secrecy, both of the Business itself, and likewise of which I would not should be known to the King for 10000 *l.* being content with what Proportion it hath pleased God to assign me, as well as with the King's Revenues. Nor shall I wholly, or fully, discover the vast Proportion of Gold I discover'd there, being so much, not fit to be communicated to Paper, as not knowing to whose Eyes, or through whose Hands this may come. I shall only tell you, I was more troubled to obscure its Abundance from my Fellows, than to bring down what I got; and, I am confident, that if your self go upon this Design, and follow the Directions of my Journal, and, attain your Purpose, you your self will be of my Opinion; for, as it is said, *What will the whole World profit a Man, if he lose his Soul*: So I say, What will the Riches of both the *Indies* advantage, if thereby you forfeit your Security, Life, and Freedom? And how will you be assured of any of these, if these Things should come to Knowledge of such as have Power of you, and to command you in what they please: That I do truly tell you, did I not value my own Peace and Quiet at so high a Rate as I do, I should come willingly, and

manifest it to his Sacred Majesty ; though I am not satisfied in that neither, as not knowing whether the Information may prove good or bad to the Publick ; however, I conjure you a-new, that, whatever you attempt, you conceal me, so that directly or indirectly I be not discover'd.

IF you go on the Business, let your Boat be flat-bottom'd, for mine being some seven Tons, or thereabout, and made after the common Fashion, was extremely troublesome, both at Fords and at Falls, where we were forced to unlade her ; and, having unladed her, to heave her, or launch her over Land : You ought also to have a little Boat for common Use, which you will find extreme useful. You advised me to take 20 Pound of Quicksilver, for Trials ; if you go, take at least 100 Pound, for some in working will be lost, as you know, better than my self : Your Advice also, for 50 Pound of Lead, is too little, take 150 Pound, much more you cannot well carry, for the pestring of your Boat.

THE *Sal Armoniack* I used little of, for it I can give you no Advice : The *Borax* I used all, wished for more, if you go, carry 50 Pound ; my Sand ever did me rare Service, I used it all, better have 10 Pound too much than too little, therefore take 40 Pound. I am confident, if I had carried the Philosophers Bellows, I had done very well ; I was so troubled with fitting the other, tho' I confess them better when a-new placed. *Antimonia Horn* did me little Service ; I believe it rather from my Ignorance, or wanting the perfect Use and Instruction you gave me. Ingots I would take two, I carried but one, I wanted another for Expedition.

Wedges 12, with a Sledge or two, or Beetle ; for about 12 *English* Miles from the first Fall, or somewhat more to the Southward, in the Side of a barren Rock, looking Westward, there

there is a Cliff in the Rock, rather

most rich between the Stones, almost half a Handful thick in some Places. Our Pick-axes did here stand us in no great stead, but having with us some Iron Tools, that we could hardly spare, with much ado made a scurvey Iron Wedge, and presently we found the Benefit of that, for some 12 or 14 Days, till improvidently one of us driving the Wedge up to the Head, and not having another to relieve it, we were forced to leave it behind us, to our great Loss and Grief. Wooden Bowls from *England*, six or eight, are very necessary, and will do better than Gourds, that I was forc'd to make use of; you may take Store of them, 'tis no Sore.

FOR the Crucibles I must inform, that four large melting Pots, in our large Work, will stand you much, and make better Dispatch than six Nests of Crucibles; though you cannot well spare those, I was forced to make use of a broken Earthen Pot, that I carried along with me; I made use of it till it broke, had I had Crucibles, and Pots enough, I had brought so much Gold in Sand or Tyber.

FOR the separating and dissolving Waters, I used but little, because their Use was troublesome, neither had I Conveniencies to erect a Still a-shoar; but for the *Aqua Regis* I used it all, and could have done more, if I had had it; yet, in my Opinion, the Trials of Quicksilver are better, had I had it. But I carry Coals to *New Castle*; you know better the Operation than my self. Let your Mortar be of Iron, and large; I wish I had follow'd your Directions in that, for my Brass one put me to a double Trouble, and I was enforced to leave the Refining of much, till I came into *England*, for the *Mercury* got a *Spurca* from thence, which is communicated to my Gold, which no Art, I understand,

stand, could free it from; in this Particular you left me lame, or my Memory much failed.

THERE is a Tree much like our Corners in *England*, but very large, which we felled, and made a Shift to make Charcoal of, which we did thus; we cut off the Boughs, for we wanted a Saw, and therefore could not meddle with the Body of the Tree, and cut them into short Pieces; then we digged a good large Pit, or Hole, in the Ground, about a Yard wide, and so deep, or deeper; in the Bottom we kindled a Fire, and filled it with Wood, and, when it was well burn'd, threw Earth upon it, and damped it; and, when it was cold, we took out the Coals: You will easily find the Place, if you observe but the Cautions; you will come to a broad gathering together of Waters, not much inferior to *Ronnander Meer*, in the Edge of *Lancashire*: Here we spent a Week in searching many Creeks and In-falls of Rivers; but we followed that which points South East and by East. My miserable Ignorance, in the Mathematicks, cannot direct you, neither for Longitude or Latitude. Up the bustling Stream, with sad Labour, we wrought, and sometimes could not go above two Miles in a Day. You must pass the first Fall; yet there my Exceed of Gold was 47 Grains from 10 Pound of Sand. When we, or you come to the upper Fall, you will be much troubled, I believe, as well as I, to get your Boat over Land; but being up, proceed till you come to the In-fall of a small Stream to the South, directly thence listen, and you shall hear a Fall of Waters; you cannot get your Boat thither, by reason of the Smallness of the Brook; you will there find our Reliques on the Side of the Rock, with many of our Names, I mean, Letters of our Names, cut with our Knives. Here, tho' the Sand, by the Wash, yield plentifully, yet do you ascend the Top of the Rock, and, pointing your
Face

Face directly West, you will observe a Snug of Rocks somewhat to the Left Hand of you; and, under that, if the Rains and Force of Weather have not washed away the Earth and Stones, you will discover (they being unmoved) the Mouth of the Mine it self; where, being provided with Materials fit for that Work, you will not desire to proceed any further, or with a richer Vein.

Take this, all along, for a constant Rule, which I, in my Search, observed up the River, That in the low, and woody, and fertile Country, I could never find either Metal or rich Mine, but always among barren Rocks and mountainous Countries, and commonly accompanied with a reddish Kind of Earth. Other Instructions I shall not give you, being (as I conceive) a thing needless to you, unless I should return you your own Principal, this being but only the Interest of what is due, besides that Obligation which tieth me unalterably to remain, &c.

I began my Voyage up the River, *December* the 4th, about two Hours before the Sun set; in my Company no more than seven Men, besides my self, all *English*, and four *Blacks*, whereof one was a *Maribuck*, who, being acquainted with the *Portugul* Language, I intended for an Interpreter, if I should stand in need; but the main was, to help us in our Labour against the Stream. My Provisions were chiefly of two Sorts: For my Voyage and for Accommodation, three Barrels of Beef, ten Gammons of Bacon, two Barrels of white Salt, besides Bay Salt for Trade; also two Hogsheads of Biscuit, besides Rice; half a Barrel of Gunpowder, and Shot proportionable; Strong-Water, Vinegar, Paper, Beads, Looking-Glasses, Knives 18 *d. per Dozen*, some Iron, little Brass Chains, Pewter Rings, and a deal of such like Stuff, as Occa-

Occasion permitted: The other Sort of Provisions were, a Pair of Goldsmiths Bellows, Crucibles four Nests, Scarnelles two Nests, Quicksilver, Borax, Sal-Armoniac, Aqua Regis, Aqua Fortis, a Mortar and Pestle, and Leather Skins to strain, Brass Scoops and Ladles with long Handles, to take up Sand, and other Implements for my private Design: All which had laden my Boat far deeper than I desir'd; for thereby I drew much Water, which, I was jealous, might hinder our Progress over the Flats, if we should meet with any.

December the 7th, We arrived near *Settico*, being 14 or 15 Leagues above where our Men stay'd; but passed one half League further up, where we anchored, the River there being broad, we always chusing the Middle, as being freest from Disturbance, though it oft fell out otherwise; for our ugly Neighbours, I mean the Sea-Horses and Crocodiles, (it seems) ill pleased or unacquainted with any Co-Partners in these watery Regions, did often disturb us in the Night, not only with their ugly Noises, but their Vicinity to our very Boats, which caused us to keep Watch.

December the 23d, We were much troubled that Day with getting over a Flat, under the Wash of a steep and high Mountain bearing South. Here I first put in Practice my Design, and took up some Sand at the first Trial of the Ford, and, out of five Pound Weight of that Sand, got three or four Grains of Gold. I tried also in another Place of the same Ford, but did get less. I saw neither Town, nor Houses, nor People, since we left *Baracunda*.

January the 14th, At a Ford between two high Mountains, I tried again; and out of ten Pound Weight of Sand, I washed 30 Grains of Gold. I made a Trial likewise with Mercury, and found
out

out of five Pound 47 Grains. Here my Hopes increased, yet resolved to try higher.

January the 27th, We were much troubled with great Trees that lay in the Water upon the Side of a Rock, on a craggy, barren Mountain adjoining. I ascended, with three Men with me, to make Discovery ; and carrying a Pick-Axe with me, which, as we were digging up a Piece of Ore, as I conceiv'd, we were assaulted with an incredible Number of monstrous great Baboons ; whom, no Oratory, but our Guns, could persuade to let us retreat to our Boats ; for, having killed two or three of them, so incensed the rest, that had, not the Report of our Guns terrified them, I verily believe, they would have torn us to Pieces : Having attained our Boat, I fell to try my Ore ; which proved but a Sparre.

February the 6th, I made a Trial of a certain glittering Sand, which I took up from the Side of a Rock, the River here inclining Southward, with a sudden Turning like an Elbow. The Wash of this afforded 41 Grains from 10 Pound Weight of Sand : By other Trials, from five Pound Weight of Sand, 57 Grains. Here I thought to make a Stand ; yet, upon more serious Advice, had resolved to proceed.

February the 15th at Night, a Sea-Horse struck our Boat through with one of his Teeth, which troubled us fore, being all bad Carpenters ; which caused us to unload her on a small Pinnacle to mend her ; and, to prevent the like Mischief for the future, I invented this Device, To hang a Lanthorn at our Stern ; and thereby we were freed from all After-Troubles of that Nature, they not daring to come within three or four Boats Length of Light shining in the Water.

February the 24th, I tried the Use of *Virga Divina*, upon a high, barren and rocky Mountain:

tain: But, whether it afforded no Metal, or whether my Rod, being cut in *England*, and being dried and carried far by Sea, had lost its Vertue; or, whether it hath no such Quality (which I rather believe) I am not certain. However, my Companions laugh'd me out of the Conceit.

March the 16th, Between two mountainous Rocks issued a Creek; and, putting up therein, discover'd a Fall of Waters from the South of the River. Here, making Trial by the Way, I found 63 Grains of Gold from five Pound Weight of Sand. Other Trials, more exact, afforded very large Proportions; so that here we spent 20 Days; and, plying hard our Work, in that Time had gotten 12 Pound *Troy*, five Ounces, two Penny-weights, 15 Grains, of good Gold.

March the 31st, Our Materials wasting apace, I was willing to try further, here beginning our greatest Toil; for, often in a Day, we were constrained to strip our selves, and leap into the Water, with main Strength to force our Boats and the Flats. Nor was this our greatest Affliction; for the River Water smells so sweet and musky, that we could not drink of it, nor dress our Meat with it; and, as we conceive, by reason of the Abundance of Crocodiles, which have the same Scent.

April the 7th, We perceived the In-fall of a small River South, the Current quick, the Land all rocky and mountainous, and, in the Silence of the Night, could hear the Noise, perfectly, of a great Fall of Waters; and, before the Mouth of it, anchored that Night.

In the Morning, into that we put, and came as near the Fall as we well could. Our Water failed; but our indefatigable Industry overcame all Difficulties; for, what I could not by Water, I did attempt by Land: Where arriving, I found the long expected

expected End of our most toilsome and long Voyage; for, I believe, never any Boat, nor any Christians, have been so high in that River, as we. Here, upon the first Trial I made, the Exceed of Gold was so much, that I was surprized with Joy and Admiration: However, here I was resolved to set down my Staff; and, to that End, the first thing I did, was to go the Boat; and, about a League and half thence, I found Wood. Here we practised to turn Colliers, and laded our small Boat with as much as she could well carry back; we went and fell to Work, for which I hope (to God alone be Praise) none of the Company hath Cause to repent, for the great Pains and Labour he took, tho' we chose the worst Time of the Year almost, the Waters being then at the very lowest; but had we gone immediately after the Rains, which is *June, July and August*, or before the Waters were fallen so low, we had been free from much of that Trouble, at Fords and Falls, by having Water enough to carry us over.

At the End of the Paper are these Words,
Transcribed verbatim from a Paper Manuscript,
lent me by Mr. Fr. Lodwick, Octob. 2. 1693. by
R. HOOK.

This Paper (which I have here publish'd exactly as I found it) I not long since lent to a Person of great Quality, for the Service of the African Company, (then setting out for an Expedition into those Parts) and I hope it hath, or will, prove as much for their Benefit, as my Wishes are. The Paper seems to have been written by one that had gotten great Riches, in King Charles the II'd's Time, by his Progress up the River Gambay: And his Descriptions of the Openings, and Turnings of the Gambay, the Inlets of other Rivers
into

into it, the adjacent Mountains, &c. may be a good Guide to Undertakers, how to find out the Place, where our Author met with Gold, even to Satiety. Who he was, can scarce be known, he conjuring his Friend, Mr. Lodwick, (to whom I conceive this Letter was addressed) to the greatest Secrecy, being, I suppose, afraid to be known, or talked of, lest he should be commanded away, by the King and Government, upon another Expedition, from that peaceable and satisfactory Retirement he enjoyed, after his Acquisition of sufficient Wealth.

W. DERHAM.

Experiments and Observations about heated Iron; communicated to the Royal Society, January 3. 1693-4.

HAVING lately met with some Experiments which are not much known, tho' they are obvious, and easy enough to be observed and experimented, I thought it might not be altogether impertinent, nor unacceptable to this Assembly, to give a short, but true Account thereof; and so much the rather, because they are very pertinent for the Proof and Confirmation of a Theory which I have formerly read before this illustrious Society, and have published in the 8th Observation of my *Microg.* for the explicating the Phænomena observable about the Sparks of Fire, struck from the Steel, by the Edge of a sharp and hard Flint, or some other such hard and stony Body: These I found to consist of small Globules, looking like melted Iron, or else some small Sliver cut off from the Steel, and thereby made red-hot, but not melted, but keeping the Shape it received by the

Stroke,

Stroke, or Gash of the Stone ; which Phænomena I did there thus explicate. — *It seems that some of these Sparks, &c. Pag. 45. Line 24, to Pag. 46. Line 14. — Muscovy Glass.*

T H E R E are two Particulars, therefore, that I have there alledged, which, by the Experiments I am now to mention, will receive great Confirmation. And the first of these Experiments is, That two Smiths, taking each his small Bar of Iron, both perfectly cold, and each of them hammering his Bar upon the same Anvil with small Hammers, in a very short Time, and with not very many Strokes, reduced them both to so great a Heat, that immediately laying them one upon another, and continuing to hammer them a very small Time longer, they were thereby perfectly welded, or joined together into one Piece, as firmly, as if they had been welded the common Way, by being sufficiently first heated in the Fire, and then hammered together. This Experiment I have not yet seen tried my self, but I have been assured of the Truth of it by a knowing Person, who saw and examined all Circumstances thereof, insomuch as I do no way doubt the Truth and Certainty thereof.

T H E other Experiment is this, That taking a Bar of Iron, and heating it to a white Heat, so that it spurts, or darts out of it every Way, very shining and fiery Rays ; then immediately laying the same on the Anvil, or a Tile, and blowing the glowing Iron with a Pair of Bellows, instead of cooling the same, as most would be ready to expect, the cold fresh Air from the Bellows will make it glow and burn much brighter and hotter, and will continue to do so for a considerable Time ; and if the Bar be sufficiently heated at first, the Bellows, by so blowing, will melt the same, as if it were Pitch or Rosin on Fire. The last Part of this Experiment I have

I have not yet verified my self, but the former Part I have, and observed it to burn and waste under the Blast of the Bellows, as if it had been a Piece of kindled Charcoal, so blowed upon; and the Flame, or Light thereof, to be so very strong and vivid, that one cannot well endure to look upon the same, without much offending the Eyes, as if one look'd upon the very bright Face of the Sun it self.

By the former Experiment it is evident, that the Force of the Blow or Stroke, which is able to cut off a Sliver of hardened Steel, may not only be sufficient to heat the same, to a Degree sufficient to set Fire on the Tinder, but to intend it, so far as to make it of a welding or white Heat, which having acquired, and flying off into the Air, with a very quick Motion, by the 2d Experiment, 'tis evident that the Operation of the Air is sufficient to intend the Heat yet further, so as to melt, or vitrify the same, and thereby to cause it to be formed into a Globule, Ball, or Shell, as it often appears through the Microscope. All which Effects are more easily perform'd on so small a Body, as are those Slivers which are struck or cut off from the hardened Steel. But the Globules, Balls, or Shells, that are made by the melting of the heated Iron, blown on by the Bellows, are much bigger, and more conspicuous, but of the same Form and Substance. Nor is this Combustibility peculiar only to Iron, tho' therein it be very notable and conspicuous, but the other Metals have also their Combustibilities in their distinct Kinds, as Copper, Brass, Lead, Tin and Silver; upon each of which the Menstruum of the Air will work and dissolve, or burn them when they have first been prepared by a proper Degree of Incallescency, as I shall, at some other Time, make manifest, by plain and evident Experiments.

*Dr. HOOK's Account of Mons. De la Hire's
Discourse of Frost. 1694.*

I HAVE have perus'd the Book of *Dan. Bartoli*, concerning Frost and Ice; and tho' he hath many Arguments to destroy the Sentiment of several of the Moderns on that Subject, of *Valesius*, *Des Cartes*, *Mr. Boyle*, *Olaus Magnus*, *Sir Kenelm Digby*, &c. yet I do not find any other Doctrine affirmed concerning it, but that he conceives it done by a nitrous Substance, which is of a cold and dry Nature, which operates after the same Manner in coagulating the Water, as the Runnet doth in coagulating Milk; but, how that is done, I do not find he does explain.

HAVING therefore fail'd of my Expectation from him, I resolv'd to see what Satisfaction I should have in perusing a Discourse, upon the same Subject, of a much newer Date, namely, that of *Mons. De la Hire*, publish'd at *Paris* in 1694. whereas that of *Bartoli* was publish'd at *Rome* 1681. This I found to be much more concise, and plain, and positive in what he has deliver'd, and much more clear in explicating of his Notions and Conceptions of it; so that tho' I could not meet with such an Information concerning Ice and Frost, as I could have wished, yet in perusing 16 Pages in *Quarto*, which is the whole Treatise, I was satisfied that I understood fully what he intended to communicate; whereas I was to seek, what was intended by the other, in almost ten Times the Number of Pages.

Mons. De la Hire then begins his Discourse, by defining or explaining what he means by Cold; that is, the sensible Quality in Frost; and this, he says, is nothing else but a less Agitation or Moti-

on of the aqueous Particles, whether blended with the Air, or united in a Mass, than of the like Particles in the Skin, or Pores and Vessels of our Body. He might, he says, have added another Assertion, that all the Agitation of aqueous Particles proceeds from that of the subtile Air; but he thinks it sufficient, for this Discourse, to shew how all the Phænomena of Cold will be plainly solved, by the Explication he has premis'd.

NEXT, he says, that these Particles are depriv'd of their Motion by certain Particles of Salt, which are very minute, long, stiff and sharp, which, by their Motion, are easily carried and blended with the Air, but do more easily insert themselves into the Particles of Water, than of any other Body, nay, even than of the Salts themselves, from whence they proceed, which he reckons to be from common Salt a little, from Niter more, but most of all from *Sal Armoniack*, which Salts do therefore easily dissolve in Water; that these Particles do penetrate Metals, and even Glass, but that they are most entangled, and stay'd by the Particles of Water, which he supposes, with *Des Cartes*, to be long and flexible, like Strings or Threads, and by that Means they destroy the Motion or Fluidity of each other, which composes a solid, hard and dry Body, which is Ice. This Ice, he says, encreases Extension, by Means of these Salts, and so breaks the Vessels that contain'd the Water; and, being so extended, is lighter, and so floats on the Water. Hence 'tis, he says, that Blebs are form'd in the Ice; but his Explication of this Phænomenon is not consonant to the other Suppositions. By the bye, he explains the Expansion of Water by Heat, and that he makes to proceed from the Expansion of the Parts of the Air contained in it. Hence he concludes, that there is a middle State of the Water,

which

which is its specifick Expansion, and it is then cold, because tho' it may be easily moved, and so retain Motion enough to keep it fluid, yet it has so little Motion of its own, that it communicates none to other Bodies. The Reason, why Oils and Spirits freeze not, he says, is because they have few of those entangling aqueous Particles: By this he gives a Reason of the not freezing of other Bodies. To fortify his Hypothesis, he explains the Experiment of the Expansion of Spirit of Wine, by the Application of Snow; and freezing other Bodies by Application of Niter and *Sal Armoniack*, and Spirit of Wine; and, by the Way, he tells a pretty Method of cleaving Mill-Stones, by the swelling of small wooden Pins, drove into certain Holes, drill'd in a Line on the Stone where 'tis to be cloven. He takes Notice also, that the Refraction of Ice is less than that of Water, and quotes his own Publication of it in 1693. though it was shew'd by me, to this Society, 30 Years before; (but 'tis not usual for those Writers to own Discoveries to be made by any but themselves, who take themselves to have an Empire over all the rest of the World). He also takes Notice of several other Phænomena, and Experiments of Ice and Frost, mentioned by Mr. Boyle, but without naming him. Upon the whole, I conceive, he has more particularly applied the *Cartesian* Notions of Particles, Motions, Figures, &c. to the Explication of these Phænomena of Cold: But as the Supposition of such qualified Particles is wholly precarious, so neither will those, without a great many other supplemental Suppositions, suffice to solve the Phænomena satisfactorily, unless the Particles be supposed to act and operate by Instinct; and tho', possibly, they might serve to put a seemingly probable Explication of these Phænomena of Cold, by supposing them thus, or thus, qualified

and adapted; yet, I very much fear, there are some Phænomena of Heat, or of other Qualities, wherein the same Particles of Bodies are necessary to be introduced as the principal Agents, tho' their Actions in those be quite contrary to their Actions in these. It would be, therefore, but a second lost Labour, to shew that these Particles are of another Nature than what they are here supposed, and to assign them other Figures, Motions, and Qualifications: Because, first, it would be almost as much Labour to demolish this Fabrick, as it was to raise it, and a third fruitless Labour to erect another. Nor can it be expected to be otherwise, till such a Structure be founded upon a natural, firm, and solid Ground, and not upon feigned and imaginary Suppositions.

*An Instrument of Use to take the Draught,
or Picture of any Thing. Communicated
by Dr. HOOK to the Royal Society,
Dec. 19, 1694.*

AMONG the Instruments that may be of Use to curious Navigators and Travellers, one is, for procuring the Pictures, Draughts, or true Forms and Shapes of such Things as are, or may be, taken Notice of by them; that is, not only of the Prospects of Countries, and Coasts, as they appear at Sea from several Distances, and several Positions; but of divers In-land Prospects of Countries, Hills, Towns, Houses, Castles, and the like; as also of any Kind of Trees, Plants, Animals, whether Birds, Beasts, Fishes, Insects; nay, of Men, Habits, Fashions, Behaviours; as also, of all Variety of Artificial Things, as, Utensils,

files, Instruments, Engines, Ships, Boats, Carriages, Weapons of War, and any other Thing of which an accurate Representation, and Explanation, is desirable. For, tho' a Description in Words may give us some imperfect Conception, and Idea, of the Thing so describ'd; yet no Description, by Words, can give us so full a Representation of the true Form of the Thing describ'd, as a Draught, or Delineation of the same upon Paper. Nor can we so perfectly conceive, or imagine, the true Colours, by Words, as by seeing the very Colour it self imitated and compared with the Life, or the real Thing: Whence we find how imperfectly the Colours of Plants are represented by Herbals, which are wash'd, or colour'd, only from the Descriptions which are made of those Colours in the Books.

Now, though this be not a new Design, or a Thing that has never been done before by any that have given us Accounts of their Travels; yet, if we do but consider, how the most of those have been done, it will, I conceive, make this, which I propound for this Effect, so much the more valuable. 'Tis well known, that the Books commonly made for the Use of Seamen, (now commonly called *Wagoners*, because one *Wagoner* printed a Collection of many such Observations) that these Books, I say, are full of the Prospects of Countries, as they are said to appear upon the Sea, at such Distances and in such Positions: And I lately saw a Book containing the Prospects of all the Western Coasts of *America*; but any one, that understands Prospect, will easily discern, how rude, imperfect, and false a Representation, all such Books contain of the Places themselves: For, not to mention the Impossibilities they often represent, as the Over-hanging of Mountains for half a Mile, or a Mile, which, tho' the Mountain were

made of cast Iron, were impossible to be sustain'd in such a Posture : The extravagant Heights they generally raise the Hills to, and the sudden and very decline Descents they make them have into the Vallies, do plainly enough demonstrate them to be no true Representations of what they are design'd for. And, indeed, they are most made by the Hands of the Mariners, who are, generally, very little skill'd in the Art of Delineation ; and, therefore, 'tis not to be expected that they should be very exact : However, even these are of very good Use for Navigators ; and they furnish them with a better Idea of the Appearance to be look'd for, than Descriptions by many Words would inform them. Again, we find that many Relations of foreign Countries do give us Pictures of Towns, Prospects, People, Actions, Plants, Animals, and the like ; and those beget in us Ideas of Things, as they are there represented. But, if we enquire after the true Authors of those Representations, for the Generality of them, we shall find them to be nothing else but some Picture-drawer, or Engraver, here at Home, who knows no more the Truth of the Things to be represented, than any other Person, that can read the Story, could fancy of himself, without that Help. Such are all the Pictures in the Books of *Theodore de Brié*, concerning the *East* and *West-Indies* : Such are also the greatest Part of the Pictures in Sir *Thomas Herbert's Travels* ; and those of Mr. *Ogylby's Asia, Africa, and America* ; which are Copies of the *Dutch* Originals, and are, originally, nothing but Mr. Engraver's Fancy : So that instead of giving us a true Idea, they misguide our Imagination, and lead us into Error, by obtruding upon us the Imaginations of a Person, possibly, more ignorant than our selves.

IT is, therefore, the Interest of all such, as desire to be rightly and truly informed for the future, to promote the Use and Practice of some such Contrivance as I shall now describe ; whereby any Person that can but use his Pen, and trace the Profile of what he sees ready drawn for him, shall be able to give us the true Draught of whatever he sees before him, that continues so long Time in the same Posture, as while he can nimbly run over, with his Pen, the Boundaries, or Out-Lines of the Thing to be represented ; which



being once truly taken, 'twill not at all be difficult to add the proper Shadows and Light pertinent thereunto. By the same Instrument also, the Mariner may very easily and truly draw the Pro-

spect of any Shore, and from Time to Time denote the Rising thereof, as he does nearer and nearer approach it, and the Depression, or Sinking of it, as he does recede.

THE Instrument I mean for this Purpose, is nothing else but a small Picture-Box, much like that which I long since shewed the *Society* for Drawing the Picture of a Man, or the like; of the Bigness of the Original, or of any proportionable Bigness that should be desired, as well bigger as smaller, than the Life; which, I believe, was the first of that Kind which was ever made, or described by any. And, possibly, this may be the first of this Kind, that has been applied to this Use; tho', upon the first Institution of the Royal Foundation of *Christ-Church*, I propounded it to the Governors there, for the Use of the Children: But Sir *Jon. More* undertaking to write an Institution, and having omitted it, it has not been there brought into Use.

*A Way to measure Heights and Distances,
&c. at Sea, Feb. 13, 1694-5.*

THAT, which I shall at present explain, is a Method of Measuring the Bearing and Distance of Objects seen at Sea, such as Ships, or Shores, Islands, Promontories, Castles, Towns, Mountains; their Heights, as well as Distances: Also the Course, Length, Breadth, &c. of Rivers, and the like: As also, for knowing the Distance from any Light, or Light-House, seen in the Night. Now, tho' experienced Navigators do, by long Practice and Use, give pretty near Guesses at them; yet the Way I shall propound, I conceive, will come much nearer, and be much more

more certain, and may easily enough be put in Practice ; which if the Gentleman, that describ'd the Coasts of *England*, had known, or put in Practice, I conceive, he would have prevented many Mistakes he has therein committed. However, tho' it be now too late for that Purpose, yet it may be of good Use for such as may attempt the Amendment of those, or any other Coast-Maps, or Charts, for the future. And I have the rather mentioned it at this Time, for that somewhat of that Kind is shortly design'd to be undertaken. And it would be, as I conceive, very much the Interest of all Mariners, Merchants, nay States that are concerned in Maritime Affairs, to be at a constant Charge to have such a Design prosecuted, till it be compleated for the whole World, at least for all Coasts that are traded to, or much frequented, or which are often passed near, or touch'd at, in farther Voyages ; that Seamen, in Case of Distress, might know where to find convenient Harbours, and also Accommodations of fresh Water, Wood, Victuals, &c. I know the Work is great ; yet it is necessary, and ought to be done, some Time or other, and therefore the sooner the better. Somewhat of this Kind, I know, is accidentally done almost by every Navigator, and recorded in their Journals ; but most of those being kept by themselves, they are of little publick Benefit, and serve only for their own future Information. But those who have made it their Business to collect and digest such Journals, and to print the Results thence deduced, which the *Hollanders* and *English* have prosecuted more than any Nation besides, have very much deserved the Acknowledgments of all the rest of the World ; as all such for the future will do, who shall promote and encourage such a Work.

THE Way then, which I propound, is perform'd by taking the true Bearing of an Object at the same Instant from two Stations, which, the farther they are removed from each other, the more fit they are for this Purpose. Now, because both these Stations are to be comprised within the Ship, or Vessel, made Use of, I would have them to be, at the Extremities, of the Length of the Vessel, to wit, at the Stern and Head, or in the Round upon the Head of the Boltsprit, which will add somewhat to the Distance of the two Stations; for, upon the Measure of that depends the Measure of all the other Lengths or Distances. Now, in each of these Places which are pitched upon for the Stations, I would have a fix'd Frame, or Pedestal, for the holding of the Instrument to be used on it, and the Instrument so fixed to it, as to remain firm and steady in any Posture desired, and yet, with the greatest Ease imaginable, so to be moved, as to respect directly the Object requir'd, and, when the Observation is made, to be as easily removed, and as easy again to be fixed. The Instruments I would have to be Sextants of about two Foot Radius, most exactly graduated; on each Side from the middle Line, that is, to 30 Degrees on each Side, and to be fitted with Perspective Sights, whose *Rete*, or Sight-Point, shall always be in the Center of the Instrument, and that Center always in the Line and *Terminus* of the Distance of the two Stations, which shall be invariable, however the Instruments are moved to respect the Objects; to which Purpose each of the Instruments shall have a double Motion; one of which shall be exactly upon the Line of Distance of the Instruments, whereby the Plane of the whole Instrument is moved; and the other of the Sight, upon the Plane of the Instrument it self, so as to respect the Object, and give the Angle that the

Line

Line of the Sight makes with the former Axis of Motion, or with the middle Line of the Instrument; which middle Line ought to be exactly perpendicular to the Axis of the Motion of the Plane of the Instrument, which is the Line of Distance. Next, there should be two expert Observers placed to make Use of these Instruments, and each of them, at the same Instant, should direct his proper Sight to the same Point of the Object; which, that it may be done the more exactly, I think it convenient, especially in large Ships, to have a Line, Packthread, or Wire, to pass between the two Observers, by which they may, at the Instant they desire, advertise the corresponding Observer, of what will be necessary, according to the Signs or Directions they have before mutually agreed upon. By this Method, if well executed, I do not doubt, but that Heights, Distances, and Positions of Objects, seen on the Sea, may be estimated ten times more exact than any that are now made by Judgment, (as they say) or rather by Guess. And, if any one will endeavour to put it in Practice, I shall be very ready to explain any Part thereof more fully, and particularly, for his Information.



*Dr. THO. SMITH's Letter to Dr. HALLEY,
JUN. 12. 1695. concerning Mr. Greave's
Observations in Egypt.*

Excerpta out of Mr. Greave's Note-Book.

IN his Astronomical Observations, he begins the Day with the Rising of the Sun, as seeming most natural.

Obliquitas Zodiaci, A. C. 1639. $23^{\circ} 30' 15''$.

THE Colours of the Planets not different at all from what the Antients make them, and from what we see in *England*.

A. D. 1638. Mense Decembri.

Declinatio acus magneticæ a meridiano Alexandriæ occidentem versus, e multis observationibus, iisque accuratis, $5^{\circ} 45'$.

J. GRAVIUS ANGLUS.

THE Altitude of the Pole at *Alexandria* $31^{\circ} 10'$ N. but I find, in other Places of the Book, $31^{\circ} 5'$ and $31^{\circ} 3'$. [Which of these three Observations he determined to be the most accurate and certain, I could not find.]

Posidonius, as *Cleomedes* writes, observ'd the Altitude of *Canopus*, at *Alexandria*, to be $7^{\circ} \frac{1}{2}$; he observed it there to be but six Degrees, and almost half. *Canopus*, says *Ptolemy*, has Long. $17^{\circ} 10'$. Lat. Austr. 75° . *Snellius* finds the Altitude of the *Æquinoctial* at *Alexandria* to be $58^{\circ} 58'$, and so the Pole consequently $31^{\circ} 2'$. The Sun's Meridian Altitude taken by him,

11 March 1637. S. V. at *Galata*, by *Constantinople*, $49^{\circ} \frac{1}{100}$.

11 Sept. 1638. at *Rhodes*, $53^{\circ} \frac{53}{100}$.

19 Decemb. 1638. at *Alexandria*, $35^{\circ} \frac{201}{1000}$.

The Diameter of the Sun, taken January 25. S. V. 1638. $2^h \frac{40}{100}$ p. m. and so again 4^h p. m.

As 10000 to 103,

So 100000 to 1030, the Tangent of $35' 25''$ the Diameter of the Sun.

Jan. 29. S. V. 1638. about 5^h p. m. he found the same Diameter.

At the Rising and Setting of the Sun in *Ægypt*, especially about *Alexandria*, there is great Store of Vapours. At a good Distance from the Horizon, the Body of the Sun grows ruddy, and appears bigger than it usually seems in *England*. Few Nights, and those without Wind, that he could see the Stars near the Horizon: The Reason was, because when the Winds blow, they raise Sands, which make, oftentimes, the Sky to look, as when it is hazy Weather in *England*.

He could observe no Spots in the Sun, for several Weeks together, in the latter End of *January*, *February*, and *March*. On the 5th of *April*, S. V. 1639. three little Spots in the Sun, whereof two close together.

At this Day but four Channels, or *Ostia*, of *Nile*; two natural, *Damiata* and *Rosetto*, which make the *Delta*; and part some twenty Miles below *Cairo*: Two Artificial, 1. The one on the South Side of *Alexandria*, and has its Beginning some 30 Miles above *Rosetto*: By this all Merchandise was anciently brought to *Alexandria*, which now comes from *Rosetto* by *Giermas*, with great Uncertainty, by reason the *Bocca* of *Nilus* is very dangerous, both because of the N. W. and N. N. W. Winds, which bar in all those Ships, as also for the Sands and Shallows;

Shallows ; tho', at the overflowing of *Nilus*, good Ships may pass.

2. THE other at *Boulas*, where it falls into a *Sinus* of the Sea ; *i. e.* in the Mid-way between *Rosetto* and *Damiata*, and like to that at *Madiga*, which is in the Mid-way between *Alexandria* and *Rosetto* : Between these two Places, about 40 Miles *English*, *Rosetto* lies from *Alexandria* East and by South.

THE Course of *Nilus*, allowing for the several Turnings S. S. E. wherefore *Memphis* and *Alexandria* cannot be in the same Meridian, nor *Rhodus* ; for from *Rhodus* they sail S. S. E. to *Alexandria*.

Dr. HOOK'S Contrivance to augment the Divisions of the Barometer, in a Discourse to the Royal Society, Dec. 17. 1695.

THE following Contrivance I met with in a small Script of Paper, and find it was a Part of a larger Discourse on the Subject, which never came to my Hands.

W. DERHAM.

THE other by a Counterpoise and Wheel, whereby I could make an Index point the Divisions of a long spiral Line, not only of one Revolution of that Line, but many whole Revolutions in a spiral Line : So that if one Round of the Spiral were six Foot Compass, and so easily susceptible of 1000 Divisions, I could easily make it move six or eight Revolutions, each of which should be equally capable of the like Number of plain and very visible Divisions, which maketh the Difference of two Inches in the common, to become 40 or 50 Foot in this, and consequently capable of
eight

eight or ten Thousand Divisions, as sensible and plain to be seen, as the half Decimals of an Inch; and the Contrivance is such, that there is no Manner of Stiffness or Rubbing in the Contrivance, but each of these Divisions will be as exactly pointed to by the Index, as the Index, in the common single Barometer, can be pointed to by the Surface of the Mercury; which, since it is usually comprised within 40 Decimals, or Parts of an Inch, or two Inches, and this Way it may be made 40 or 50 Foot; it follows, that consequently the Alterations will be 200, or 250 Times more visible and discoverable, than by the common Barometer.

AND having brought it to this Pass, that I could, by these Methods, be able to make the smallest Alterations, (that have yet been imagined) to be sensible and measurable, I desisted from improving this Subject, by further Contrivances upon these Principles. However, I may, in Time, shew some other Instruments for Discovery of the Weather, that may, come to be of as good Use.



Dr HOOK's Conjectures about the odd Phænomena observable in the Shell-Fish called the Nautilus. Read to the Royal Society Dec. 2, 1696.

FOR the right Understanding of this Matter, I shall give a brief Account of this Animal from Aristotle, Pliny, Oppian, Ælian, Bellonius, and their Transcribers, Gefner, Aldrovand, and Jonson, viz. That the Nautilus is an Inhabitant of the Deep: That it hath three Motions, viz. a Power to raise it self up from the Bottom to the Surface of the Sea; that it can sail thereon; and again sink itself to the Bottom: That its Shell is made very commodiously for these three Motions, with divers Cells: That it can erect its Shell edge-ways for Sailing: That it hath two (some say three) Arms, or Claws, with a thin and light, but strong Membrane between them, like that of Palmiped Birds: That this it hoists up and spreads like a Sail, and is driven thereby on the Surface of the Sea: Besides which, that it hath also other Parts on each Side of it, that it lets down to steer and guide its Course, as with a Rudder, so long as no Danger is nigh: But, if it perceives any Danger from the more powerful Animals, or Storms, that then it fills its Shell with Water, and suddenly sinks itself to the Bottom.

BUT for the Reader's Diversion, if he hath a Mind to see Oppian the Poet's elegant Description of this Inhabitant of the Waters, as translated by Lippius, he may find it thus in Aldrovand. de Testaceis, l. 3. c. 5.

Quem dicunt nomine vero
Nautilon, insignem ponto sua gloria fecit,

Per

Per freta dum cautus sub Navis imagine ludit.
 In fabulo domus est, summa defertur in unda
 Pronus, neu pontum capiat, plenusque gravatus,
 Cum nando vehitur, per fluctus Amphitrites,
 Extemplo versus tumidam per marmoris undam
 Labitur, ut nandi doctus, puppisque peritus.
 Atque pedes geminos tendit, de more Rudentum,
 Quos inter medios tenuis membrana tumescit
 Extenta, atque pedes contingunt æquora subter,
 Themoni assimiles, navem, piscemque domumque
 Deducunt. Si forte malum supereminet ullum,
 Absorbet fluctus intus, lymphisque gravatus,
 A tumidis trahitur cum pondere fluctibus unda.

*Hinc (saith Aldrovand) homines navigia inven-
 nerunt, Et ex eodem Oppiano citat Lilius Gregorius
 Gyraldus.*

W. DERHAM.

The Account which Dr. Hook gives is thus :

THE Structure of the Shell of the *Nautilus*,
 which as it is very curious, and indeed very
 wonderful, so it is not less instructive to one that
 shall contemplate on it ; and to me, as yet, it ap-
 pears to be the only Instance of a Contrivance
 truly wonderful ; for that I do not know any thing
 like it in the whole Genus of Fishes, tho' there
 are some Instances that tend that Way. It is, in
 short, this, The Creature, it seems, to whom this
 Shell is adapted, by Accounts we have of it, is an
 Inhabitant of the Abyfs, or Great Deep ; which
 how deep it is none yet knows, nor will know, till
 some of my *Nuntii ad Abyssum* (which I have for-
 merly acquainted you with) be sent thither, and
 bring back Tidings concerning it ; or, till this our
 present *Nuncius* can find a Way to manifest, how far
 he has ascended to come up to the Day, or how far

he descends to go to his Resting-place at the Bottom of the Sea. For these Progresses he is said to make, besides his Voyage, when he sails on the Top of the Ocean. Now being constituted by Nature to perform these, and yet to be without Wings or Fins, to help himself by Labour to move in any of these three Ways ; it is wonderful to consider, by what a plain and easy Contrivance the All-wise Creator has endowed him with sufficient Faculties to perform the same, with very little or no Fatigue at all, but to be carry'd in his Chariot, or rather Ship, from Place to Place, as he has Occasion to change his Residence.

THE Manner of which (if I am not mistaken in my Conjecture) is this : Nature has furnished him with a curious Shell, dividing it into many distinct Cells or Cavities, by certain Valves, Diaphragms or Partitions, which have no Communication with each other, but only by Means of a Gut or *Ductus*, which passes through them all from the Bowels or Body of the Creature, placed in the Cavity of the Mouth of the Shell to the very End of the Spiral Cone, or conical shaped Shell, which ends in the very Center or Beginning of the proportional *Spira*, and has there a *Spiramentum* or Vent, which I have formerly discover'd, by examining more curiously one of that Kind, by opening it, though it has not hitherto been taken Notice of by any Author that I have met with. The Axis, or middle Line of this Cone, or conically-shap'd Body is spiraled round exactly in a Plane, and not helicated on a conical Surface, as in almost all the Shells of other the conchylious Fishes, it is observable. Now this admirable Structure seems to me not a mere *Lusus Naturæ*, or a Form by Chance, to express, a Variety, but an Emanation of that infinite Wisdom, that appears in the Shapes and Structure of all other created Beings, which

is to endow them with sufficient Abilities to perform those Actions, which are made necessary to their Well-being. Now, the Relations of Histories of this Creature inform us, that it has three Kinds of Motions through the Water, that is, ascending, descending, and progressive; and since there is one Posture of the Shell, that is most proper to perform each of these, therefore it is, as I conceive, that the Shell is so contriv'd, as to be put, and kept in that Position, whilst it performs that Motion: The Shell then is contriv'd to be all a Cavity, and to have no other Part or Bowel of the Creature within the first Cavity, but only a small String, Gut, or *Ductus*, which passeth from the Body of the Creature, placed in the Mouth of the Shell, to the End of the conical Cavity. Now by this I conceive, that when this Cavity is fill'd with Water, the whole Bulk becomes heavier than the Water, and so must sink to the Bottom of the Sea: But when the Cavity is fill'd with Air, then the Whole will be boyant, and lighter than the Water, and so rise to the Top, and float on its Surface: These Powers it would have had, supposing the Cavity of the Shell had had no other but the first or greatest Diaphragm, and the rest had been one entire Cavity: But this would not have disposed the Shell to all those Motions, it is to perform, into the most convenient Postures; for that Posture, that is fittest for its rising, would not be so for its sinking, nor for its sailing, nor possibly for its Progression at the Bottom, (if such a Motion it does perform, as to me it seems rational enough to suppose) for that every one of them will need a different Posture. We find, therefore, this Cavity all subdivided by internal Diaphragms or Partitions, into a great Number of distinct Cells, (I have found 40 in some Shells) and every one of these penetrated by this Gut or *Ductus*, so that

by Means thereof, I conceive, the Animal has a Power to fill or empty each of those Cavities with Water, as shall suffice to poise and trim the Posture of his Vessel, or Shell, fittest for that Navigation or Voyage he is to make ; or if he be to rise, then he can empty those Cavities of Water, or fill them with Air which lie toward that Side, that part the Shell, that best penetrate the Water : If he be to descend, he can fill those with Water, and empty the opposite ; if to sail on the Top, he can evacuate those Cavities that will trim his Shell fit to sail with the Mouth of it upwards, that he may there expand his Sails and use his Rudders ; and if to move at the Bottom, he can fill those, and empty the opposite, so as that the Mouth may be downwards, to respect the Ground or Bottom over which he passes, so to discover his proper Nutriment or other Convenience, and to descend to it when he finds it. Now it may be imagined, and objected, that these Operations may be too notional and fanciful, and so seem to have more of Design and Counsel, than the Creature seems to be capable of : To which I answer, that it is no more, nor, may be, so much, as most other Creatures are endow'd with, and constantly perform : For whoever considers what Design and Contrivance there is for the Performance of all muscular Motion, where this or that Muscle is to be strained, and that or the other Muscle is to be relaxed, and presently the quite contrary Effects are to be effected, and all these to proceed from the Will, or Intention of the Creature that moves himself thereby, which Way it pleaseth, will not think it so strange to conceive, that this Creature may have implanted in it a Faculty, to make use of the Organs for Motions, as well as any other : There needs no Institution of a Bird to make use of his Wings to fly, or of his Tail, to poise or guide him in his Flight ;

no, Nature, or the infinitely wise God of Nature hath taken Care to give him an Instinct or Impulse, which enables him to do those Things, that are necessary to be done, for the producing the desired Effect. Now, though the shaping, and trimming, and steering of an artificial Ship, doth require the Understanding of the Men that are to act in that Ship, to know, and accordingly to dispose of all Things, for the effecting what is necessary or desired ; yet 'tis not thence to be argued, that the Operations of animal Motions must be perform'd by the Operations of Reasoning. No Man can tell how, or by what Means, he moves his Finger, or any one Muscle of his Body ; no, Nature hath set all Things in Order, and endow'd us with a Power to perform what is necessary, though we know not how, nor by what Means ; nor is the Notion, I have hinted, so extravagant, or so much beyond the other Contrivances, for the effecting of various Motions in other Animals, as some may imagine, since, when I come to treat of that Subject, I shall shew, and prove several Contrivances, that are actually made Use of, that are abundantly more wonderful.

[On Dec. 16. following, Dr. Hook resum'd his Considerations of the Nautilus, and having taken Notice of several Transmutations, as particularly of Water into the solid Parts of Vegetables, as also into Earth or Ice ; he then proceeds, and saith,]

W. D E R H A M.

BUT this Metamorphosis, or Transmutation of Elements, I take Notice of here, only by the by, as it may be of some Use for the Explication of another Metamorphosis of a contrary Nature, and that is, of Water into Air, which is by Rarefaction,

for such an Operation Nature seems to have; and somewhat of this Kind is producible by Art, as has been prov'd to this Society by many Experiments, heretofore made, for the Production of artificial Air; which, though under that Notion it seem'd not to be regarded, yet, as such another, published a good While after all those Experiments, as his own, not owning at all he had been inform'd of them, by some of the Members of this Society: But to pass by that at present (because there are Abundance of Instances of the like Nature that have been given, which I may on some other Occasions manifest) I had a further Prospect in the Success of those Trials than what was, for the like Reasons, then spoken of; one of which was, for the Solution of such a Phænomenon as this, of the floating and sinking of the *Nautilus*, which I discoursed of the last Meeting but one. It seem'd, indeed, very strange, how that Creature could so, at his Will fill, and empty, the Cavities of his Shell, with Water; it was easy to conceive, how he could fill his Shell with Water, and so sink himself to the Bottom; but then how (when there, at such a Distance, from the Air) he could evacuate the Water, and fill the Cavities with Air, that was difficult to comprehend, especially being under so great a Pressure of Water: But if Nature had furnish'd him with a Faculty of producing an artificial Air, then the Riddle would quickly be unfolded. I found, therefore, that by Art it was feasible to produce such an artificial Air, and that it was endued with a very great Power of Expansion, so that it would not only make itself Room to expand, notwithstanding the incumbent Pressure of the Air on all Sides; but, if sealed up in strong Glasses, it would break out the Sides there of, which might have as much Power of Expansion as might counterpoise,

nay,

may, out-power both the Pressure of the Air, and also the Water too, though 100 Times greater than that of the Air. It will be, I confess, a difficult Matter for me to prove, that the *Nautili* have such a Power, for that I could never yet get a Sight of that Fish that inhabits those Shells, nor do I find that any of the Authors, that pretend to describe it, have, nor has any of them given a Description of it that can give one any true Idea of it: Yet, methinks, it might be procured from some ingenious Person, that has an Opportunity of visiting the *Barbadoes*, and some of the other Leeward Islands, where there are found great Plenty of a smaller Sort of them, which though of a differing Shape, in the Coil of the conical Body, yet they agree with all the other Kinds of them in having the Diaphragms, and a *Ductus*, or Vessel passing through them all, from the Basis to the Apex of the coiled Cone, and the Axis of that Cone is also coiled in a Plane, as are all the other Kinds of the *Nautili*; of which I have one here to shew, given me by one who had a whole Box full of them, which he had there collected, and brought with him to *England*.

Some farther Observations relating to the Nautilus, and other Shell-Fish. Read Dec. 23, 1696.

W. DERHAM.

I Explain'd, the last Day, the Fabrick and Structure of a Creature, which, as Authors inform us, is an Inhabitant of the Abyss or Great Deep, which does often perform a Voyage from thence to this superior Region of the Air; and, after the Dispatch of his Business here, returns again to his own Habitation. I explain'd also, by what Method he perform'd

form'd these Voyages, as I conceiv'd, from the Consideration of the Structure of the Shell, and the Effects perform'd by it. I cannot be positive in it, as not having ever had an Opportunity to see the Creature itself: But by considering of the Contrivance of other Fishes, to help them to float in the Water, or at least to buoy them up, or counterpoise them with the Water, by the Help of the *Swim*, as 'tis call'd, or Bladders blown up by Air, or Vapours, I think there is great Probability in the Conjecture.

FOR the *Nautilus* is not the only Inhabitant of the Deep, or of the Bottom of the Sea; no, questionless, there are a Multitude of other Sorts of Animals that are there bred, and do there reside; for we do not only find Oysters, Scalops, Cockles, Periwinkles, and most other Kinds of Shell-Fish, but most Sorts of crustaceous Animals, as various Sorts of Lobsters, various Sorts of Crabs, and various Sorts of Prawns or Shrimps, and such like; nay, we find there also several Sorts of Fishes, not furnish'd either with Shells, or Crufts, which the Fisher-men always find and catch, near the Bottom of the Water, where they fish for them: And I myself have proved, that the best Place, to lay the Bait to catch Whittings, Grundells, Place, Flounders, Beards, is, at within a Fathom of the Ground, where the Depth of the Sea was about 25 Fathoms, or 150 Foot; and, from as great a Depth, I have known Lobsters and Crabs to have been taken by the same Fish-hooks, which were baited for the catching those other Sort of Fishes: And, indeed, most Part of the Lobsters, Crabs, and Prawns, are taken, in Fish-Pots, or Fish-Cages, laid at the Bottom of the Sea, when there has been found a Place frequented by them: As also Scates, Thornbacks, Monk-Fish, Dog-Fish, and the like, which are catch'd by baited Fish-hooks, laid at the Bottom
of

of the Sea, they being all ty'd by strong short Lines, ty'd to a Rope, there extended between two Stones, which there keep it extended. So that most Fish, of all Kinds, do, for the most Part, there reside, and thence it is probable to conjecture, that there they find the greatest Part of their Food and Nourishment, and that there do likewise grow abundance of distinct Sorts of Vegetables, which may be useful for that End ; for we find, in Seas that are not very deep, that divers Sorts of Algas, Sea-phans, Sponges, Cotulli, and the like, are there produc'd ; and why then may there not be Multitudes of others ? Nature, we find, does accommodate every thing it produces with all Conveniencies, necessary for its Support and Well-being, and fit every Thing necessary for the Carrying on and Perfection of its Designs ; so that I see no Reason to doubt, that these Sub-marine Regions are as well stock'd with Variety of Animals and Vegetables, as the Surface of the Earth, which is only Sub-aerial, only we are less knowing of them, because they are out of our Element, and we want *Nuntii* or Messengers, to send thither to bring us back Information, and also the Productions and Commodities that this *Terra incognita*, or unknown World, does afford. I have heretofore produced some such *Nuntii*, for this or that particular Design, but when there may be an Opportunity of sending them, I shall be able to produce divers others, for other Purposes, if God spare my Life so long as to see the Seas again free from Rovers, and that the Study of Arts does succeed the Study of Arms. It is now above thirty Years since I try'd many Experiments, for this very End, to know under how great a Pressure a terrestrial or aerial Animal could live, and consequently a Man ; and I shew'd a Way also how to supply him with fresh Air from above, to whatever Depth he should

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be able to descend, without prejudicing his Health or Life : I shew'd also how to accommodate him for seeing with Spectacles, and acting freely in the Water as he could do in the Air, by Means of other Accoutrements, whenever he was able to endure the Pressure. And I have many other Experiments, which would be not only instructive, but useful for these and other Designs, but I want an Apparatus and Assistance to perform them. And, probably, most People will treat me as *Columbus* was, when he pretended the Discovery of a New World to the Westward : But I have been accustomed to such Kind of Treatments, and so the better fitted to bear them. However, I think, that such Objections as most will be apt to make, that Animals and Vegetables cannot be rationally supposed to live and grow under so great a Pressure, so great a Cold, and at so great a Distance from the Air, as many Parts at the Bottom of very deep Seas are liable and subject to ; I say, I think that these Objections may be easily answer'd, by shewing, that they all proceed from wrong Notions that Men have entertain'd, from the small Experience they have had of the Effects, and Powers, and Methods of Nature, and a few Trials will easily convince them of the Erroneousness of them. We have had Instances enough of the Fallaciousness of such immature and hasty Conclusions. The *Torrid* and *Frigid Zones* were once concluded uninhabitable ; and to assert *Antipodes* was thought atheistical, heretical, and damnable ; but Time has discover'd the Falsity and Narrowness of those hasty Conclusions.

Dr. HOOK's Discourses to the Royal Society, in the Beginning of 1697, concerning Amber.

The Sum of Dr. HOOK's Opinion, in these Discourses, Mr. WALLER gives in this following Preface, viz.

HAVING met with a Treatise concerning *Amber*, publish'd by ——— (of which he gave an Account) he proceeds from several Observations therein mentioned, and some of his own, to give his own Sentiments, *viz.* That *Amber* being found almost all over *Prussia*, as well in the Inland Parts, as in the Sea, on the Shore, in the Caverns, Clifts, and under the Hills, by digging, and this in a Sort of *Minera arenaria*; which, by the Substances found in it, such as Shells petrify'd, and the like, *Dr. Hook* judges to be a certain Layer, or Bed of Sea-Sand, the Remains of the Bottom of some Sea that formerly covered the whole Country, which, in Process of Time, has been raised above the Level of the present Sea; but, at a certain Depth, all that sandy Bottom yet remains, containing such Substances as were there deposited, whilst it was in that State; at least, such of them as have not been rotted and consumed by Time, such as petrified Shells, Wood, Bones, with Vitriol, Alum, Niter, and Sea-Salt, together with Lumps of *Amber*, are frequently now found in digging into this Sand, for Wells, or the like. Here he has Recourse to his Hypothesis, formerly discoursed of, for the Solution of these Appearances, *viz.* That not only the Vales, and lower Parts of the Land, have been some Time the Bottom of the Sea, but even the Tops of Hills and Mountains; as the several

veral Substances now found thereon make evident. *Amber* then being thus found, either at the Bottom of the Sea adjoining, or in these Layers of Sand, the Question is, How it came there? and from whence? To answer this Inquiry, tho' the Author of the Treatise is of another Opinion, yet, from several Observations therein mentioned, Dr. *Hook* judges it to have been the Gum of a certain Tree petrified, and altered to the present State and Appearance it has. Thus far Mr. *Waller*; next follows,

Dr. HOOK'S Discourse of Feb. 24, 1696-7.

I HAVE lately ventured to assert my Opinion, That *Amber* is a Kind of petrified Resin, or the Exudation of some resinous Tree, concreted into a Substance so much seemingly different from it, that most of the Authors that have treated of it, or described it, have been quite of a different Opinion. Nay, even the last, and, I think, much the best, that is, *Philippus Jacobus Hartman*, who has publish'd a Tract, Intituled, *Succini Prussici Historia Physica & Civilis*. For, after he has disproved, as he conceives, all the Opinions of those who have writ of *Amber*, and, amongst the rest, those of such as have inclin'd to think it originally some vegetable Substance, &c. he thus concludes, p. 16. of his 2d Book. *Subterraneum utique succinum apud omnes in confesso esse, idque ex historia satis probari; cum vero, id nec duci nec fundi possit, metallis non accensendum esse, neque ex reliquis fossilium generibus terris, sulphuri aut bitumini anumerandum, quod soliditas succino major quam quæ ejusmodi fossilibus inest: Lapidem igitur reliquum esse, ut dicamus, & quidem non ex saxorum aut marmorum, sed nec ex lapidum peculiariter ita dictorum genere, sed gemmam, per quam apte responderi possit ad quæstionem, quid sit cum naturam ejus recte exprimat.*

exprimat. Now, how much the wiser we are, as to the Knowledge of its Nature and original Substance, I leave to others to judge; to me, I confess, it seems more obscure, than if he had said that *Amber* is *Amber*; for, what he understands by *Gemma*, to me seems more obscure. He has, indeed, many pertinent Relations, and Observations, which have much assisted me in my Inquiry; but the Uses and Inferences, he draws from them, are quite contrary to those which I have remarked them for. 'Tis not my Design to contradict his Opinion, or to make Objections to his Doctrines: I think it fairer to propound my own, and leave the Choice to the Judgment of such, as shall consider impartially the one and the other Deduction from the Phænomena, which I take to be what concerns his own Observations truly delivered by him. He relates then, (in his Preface) that he has three or four times visited the *Sudavean* Coast, which is the principal Place of *Prussia*, where the *Amber* is found in the greatest Plenty: And that he there did not only inform himself by what he saw, but by Discourfing and Examining the Searcher, or Fishers, for it, and the Overseers and Governors that took Care of the whole Affair, for the Prince's Interest, that he collected, and carried away with him, not only Pieces of *Amber*, but several Sands, Clays, and other Materials found with them, that he might be inform'd by Judgment of others to whom he shew'd them, &c. This Coast faces the West, and lies about 20 Leagues N. E. by E. of the Town of *Dantzick*. He adds, that it has been found also in many Inland Parts of *Prussia*, as well as upon other Shores of the *Baltick* Sea; but thinks it to have been carried by the Sea to such Places from this Shore. He mentions a Piece found at *Gilyenburg*, 20 *German* Miles from the Sea, which was found in

making a Well, which proved to yield salt, not fresh Water. Also at *Bortenstein*, a Fountain breaking out brought with it much *Amber*. And he mentions another two Miles from *Bartenstein*, which in 1666. broke out in the same Manner, and vomited, with the *Amber*, a great Quantity of Sea-Sand, which much damaged the Fields; and it hollowed the Mountain so much, that the Top sunk in, and left a soundless Abyss, or Vorago. The *Amber* thrown off was of divers Colours, and Bignesses; and there were various Pieces of Wood also mix'd with the Sand: This Efflux, at last, ceased; and it has now left a Lake, and prodigious Caverns. He says further, that digging a Well at *Aschenburg*, they found *Amber* in a Bed of Sand, like Wood; but he thinks the Wood to be Clay, shaped like Wood. He mentions also many Inland Lakes where it is sometimes found, far distant from the Sea. He mentions it found in making other Wells; one in the Year 1641, another in 1663, at whose Bottom *Amber* was found in Beds of Sea-Sand. In other Places Trees were found also in the same Sand. He relates many other Places of *Prussia*, where, after the same Manner, it has been found; and he could have instanced also in abundance more. This I find upon the Whole, that it is almost all over *Prussia*; that it is generally found in a Bed of Sand; and, that other Substances, as Wood, Iron, &c. are often found in that Sand also. These Substances, Sand, *Amber*, Wood, Trees, &c. he believes (*p.* 36.) to be the Product of the Sea; but to be convey'd thither by subterraneous Passages: And this especially, for that Planks, Iron, and other Parts of Vessels, are found in the same Sand of the Inland Lakes, and Wells, where he thinks it impossible that there should ever have been any Ships or Vessels. He mentions it to be found in *Pomerania*,
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but in small Quantities, and that only to have come from *Prussia*: Describing further the Places of the Coasts, where 'tis found in most Plenty, he says, the Rocks and Shore have many petrified Stones, and that the Cliffs, or Banks, are full of Vitriol, or Marquisite Stones; and Plenty of Vitriol, Niter, and other petrifying Salts, are found mixed with the same Sand, in which the Pieces of *Amber* are found. (p. 51.) Quantities also of Thunderbolt Stones, and *Prussian* Diamonds, or Chrystals, are also found with it. He proceeds in his 3d *Chapter* to describe the proper Vein, or Mine, of *Amber*; and this, he says, no one has truly described besides himself. He says, there are three Kinds of it; namely, a clayish, a woodish, and a sandy Mineral; in one of which it is always found: The clayish is a Sort of blue Clay; the woodish consists of fossil Wood, not vegetable, (as he thinks) but form'd out of the clayish one; some, he says, reject the clayish and sandy Minerals, and think them to be the only true *Minera* of *Amber*: But he, by many Arguments, endeavours to confute their Opinion; especially, that of those who reject the sandy, because they could not conceive, how the Sea-Sand should be carried so far from the Sea; which, he conceives, might be done by the universal Deluge, or by the Breaking out of Fountains, like that which happened 1666. before-mentioned; or, which he sticks to, that it has been convey'd from the Sea by subterraneous Caverns, which he thinks are now, and have been in Time, all fill'd up by it, and so comes to be found all over *Prussia*.

BUT the other Authors think the woody *Minera*, to be the only and the true *Minera* of *Amber*; yet *Wigandus* thinks, that the Places, where it is found, have been formerly covered and overflowed by the Sea (p. 45.) He grants, that the

Frisch

Frisch Nerwing has been so overflown, and is now firm Land; but is not satisfied concerning other Places, (p. 46.) The woody Vein at *Kraxtepellen* has much Vitriol mix'd with the *Amber*; and there is much Niter also with the Vitriol, (p. 49.) and that almost every where, where *Amber* is found, there is found much Niter, as the Miners do assert. He adds, That the Sea does petrify Substances into black Stones, as he himself observed at the Places where *Amber* is found in most Plenty, (p. 51.) The Diamonds are found in such petrified Stones, when broken, like those I have formerly described in the hollow Flints, (p. 52.) A woody Vein at *Gross Havenig* he survey'd, and found the Hill to be all sandy, but the middle Part was Wood, like rotten Trees, very black; they seem'd a Kind of Fir-Trees, others thought them Oaks; but he seems to slight what Trees they may be like; for he will have them to be only Clay, or Earth, so shaped, (p. 6.) But that at *Kraxtepellen*, he grants, was yet more plainly like Wood, having nothing of Earthiness mix'd with it. That which when moist was very black, when dried discovered more plainly its Parts, and became of a reddish Colour, (p. 61.) In the Cavities of these Trees he found them fill'd with *Amber*, and inclosed in the Wood; yet he thinks the Wood never was from Trees; tho' yet he grants, that several of his Friends and Patrons assert them to be true Wood. He adds, (p. 65.) that they found them burn clear without Mineral-stinking; but, he says, what he had found, stunk of Niter mix'd with Vitriol and Sulphur: But this Stink the *Alga* burnt also yields, and stinks somewhat like Garlick. He has much more about the *Minera* of *Amber*, &c. which I shall not trouble you with the Epitome of, at present. I shall only acquaint you with what I collected by my Observation of the whole,
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and that is, that all those Parts, where the *Amber* is found, as in Beds, has been sometimes under the Sea, and so has been raised from under it, as I have heretofore made it probable that *England* has been ; that it has been often tumbled with Earthquakes, as *England*, has been where the Fossil Trees are found ; that the Trees have formerly grown where the Banks are now found ; that the Gums of these, and such like Trees, having dropped from them, have been, by Rains, wash'd down into the River, and, by their Streams, carried into the Sea ; that greater Quantities have remain'd where the Trees grew ; and when, and where, they came to be thrown down, there they have remained, and since been petrified into *Amber*, by the nitrous, vitriolate, and other saline Substances, the Products of saline Eruptions ; and that has been the true Cause of the Phænomena.

THAT such an Exudation may be from Trees, and that it may be so carried into the Sea, I could produce many Observations ; but I shall only instance in one, at present, and that is, at *Bencoula*, on *Javaghen*, the *English* have a Fort, and Factory, all their Pitch, or Rosin, is collected out of the Stream of the River, or gathered on the Banks and Shores of the Sea : And *Dampier*, in his Voyages, tells us, That the *Cochin China* Men fetch their Pitch from *Pulo Candore*, where, by cutting a Notch in the Bottom of the Tree, it will run, every Day, more than a Quart of Rosin each Tree. As to the Probability of petrifying of such Rosins, I should say more, if I had Assistance for making Experiments, which at present is wanting. But I do not in the least doubt, but that the same thing may be perform'd by Art, which is in this by Nature. I could add many other Arguments for this Conjecture, from the Smells of *Amber*, from the Things inclosed in it ; as also some Observations

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about *Ambergreese*, and some other Petrifications ; but for these I shall take another Opportunity.

Dr. H O O K's second Discourse of Amber.

I A C Q U A I N T E D you, the last Day, with what my Author thought the most general and common *Minera* of *Amber*, which he conceives to be extended over all *Prussia*, as well in all the Inland Parts as in the Sea, on the Shores, and in the Caverns of the Clifts and Hills out of which it is dug ; and this he has confirm'd by many particular Instances, at some of which he had been a Witness, and of others he has had very pertinent Informations. This is the *Minera arenaria*, a certain Layer, or Bed of Sand, which, by the Substances found in it, does to me seem plainly to have been the Bottom of some Sea that has formerly covered all that Country ; which Country has, in Process of Time, been rais'd above the Level of the Surface of the present Sea ; but yet, at a certain Depth, all that sandy Bottom yet remains, containing such Substances as were there deposited whilst it was in that Estate and Condition ; at least such of them as have not by Length of Time rotted and consumed. These more durable Substances, I say, as the Pyrites and petrified Shells, which he calls Thunderbolts and Wood, Bones, and Amber, together with the saline Bodies of Vitriol, Alum, Niter, and Sea Salt, are found to have been, to this Day, preserved in it, and to be found unconsumed by the general Devourer of all Things, *Time*. So that, when they have Occasion of Digging into this Bed of Sand for Wells, or the like, or upon the accidental Eruption of Springs, Lumps and Pieces of *Amber* are often found in it, together also with divers of the

the other permanent Substances found commonly on the Shores of the Sea.

Now, that this is not so impossible or unusual a Phænomenon, as should startle any one's Assent, or Belief of the Truth of it, I did, 33 Years since, prove, by Multitudes of Observations (divers made my self, and many more by others) that all *England* is a most evident Instance and Testimony of the like Phænomena here; that is, that not only the Vales, and lower Parts of the Land, have been sometimes the Bottom of a Sea, but even the Tops of the Hills and Mountains, (such as we have) do plainly, and undeniably, confirm it. How, and when, these Alterations have been effected, I have long since given my Conjectures; but, if God restore my Health, I hope I shall be able to give a more particular, convincing, and satisfactory Account; not only founded upon the Observations and Phænomena I then had for my Directors, but many Hundreds of others, which I have since that Time collected; which have not only confirmed, in the general, what I then pitched upon, but has enabled me to be more particular in the Mode, Time, and Method of them.

Now, if this Phænomenon be thus solved, by granting that all *Prussia* has been formerly under the Sea, and that this *Minera arenaria* is a plain Testimony of it; 'twill not be difficult to conceive how the *Amber* comes to be found in it, since the greatest Part of what is now taken by those, whose Business it is to find it, is by Digging, and Fishing it up out of the Sand of the Shore, or of those Parts that are pretty near contiguous to it, and lie not very deep under the Water; and these Pieces of *Amber* are not found on the Top of this Sand, but buried in, and covered by it, a pretty Depth; not but that, questionless, the deeper Parts of the Bottom of the Sea, if it were in the same Manner

digged and examined, would yield as great Plenty of it; but I perceive they have not a Method of making such Experiments, and content themselves to fish for it only in the shallower Parts, and on the Shore. But still the Question is, How, and from whence came it, and by what Means to be there placed? That then is the next Enquiry.

AND here, for the answering of this, we must *audire alteram partem*, that is, the Judgment of those which he acknowledges to have been the Principal who have treated of this Subject, and those from whom (besides his own Observations) he hath collected the chiefest of his Informations, whom he calls *Triga eruditorum Prussiae*, i. e. *Aurifaber, Gobelius, & Wigandus, viri de Succini notitia optime meriti*: But, tho' he praiseth these, yet he quotes, and makes Use of the Relations and Testimonies of many others also. But yet, as to the true *Minera*, or Vein, or proper Scent of it, he rejects the Opinion of them all, and endeavours, by his whole Discourse, to confirm his own Opinion; which he calls his own, because, says he, (p. 55.) *Hic locus quidem (quantum scio) diserte a nemine explicatus*. And yet, (he adds) *Proprias autem venas ut aliorum mineralium ita etiam & succinorum extare, tam certum mihi quam quod certissimum*. (We must allow him some Grains for his Fondness of his own Opinion) *Neque solum id confirmat, quod peculiaris signorum cognitio in fossoribus requiratur, ut quæ propter singularis curæ venas indagandi & observandi cuiquam in angulo ad Gros Hubenig ubi præprimis foditur, est demandata, sed quod hujus ætatis eruditi Physici Chymici qui illa loca adierunt, aut terras inde allatas fuerunt accuratius contemplati, itidem venas mecum statuunt, sed & sequentia assertum nostrum manifestum reddent, ubi etiam per totam Prussiam si qua altius ex terra effossa, signa venarum adfuisse constiterit.*

stiterit. I shall not trouble you with the Relation of these *Sequentia*, but shall only say, that the Hypothesis I have mentioned, of the whole Country's having been sometimes overflowed by the Sea, does give a full Solution, and Explication, of them all; and, indeed, they are, most of them, very confirming Proofs of that Doctrine, if they be duly considered; as I could shew, if it were not too tedious: For, how should the broken Pieces of the pitched Plank of a Ship otherwise come to be found in his *Minera arenaria*, or *Minera lutea*, at so great a Distance from the Sea. He grants, indeed, that the *Amber* found on the Shore, in the Sand, is not there in its proper *Minera*; but is by Accident thrown up by the Working of the Sea, and, by the same Cause, covered and buried in the Sand: But, when it is found in the Inland Parts, then he thinks it to be in its proper *Minera*. *Alii arenosam & luteam negant, & casu vel forte immista succina asserunt, unam ligneam genuinam venam autumantes. Verum arenosam ut illa probarent loca quæ ex Prussia & Pomerania dedimus, quæ scilicet arenis obtutum succinum dedere. Again, De collibus vero & montibus arenosis idem asserendum*) (that is, that the *Amber* has been accidentally, or by the Working of the Sea, mixed and buried in the Sand), *difficilior est ratio, imprimis quod a mari satis sint remoti. Quis vero casus his vel fingi potest succina & quidem non contemnenda copia credidisse? An ad inundationes terrarum recurrendum? Sed illas nondum ubique historica fides satis adstruxit. Potius, ut quæ mea sit sententia exprimam, meatibus subterraneis eadem deberi contendo, & cum scaturigine aliquando ejecta fuisse non aliter quam ad Bartenstein Anno 1666. contigisse recensuimus, & hic multum arenæ simul egestum, & credo sub illa etiamnum latere succina.* So that we see he is forced, tho' unwillingly, to yield, that

'tis possible the *Minera arenaria* may be a Product of the Sea ; tho', because he finds no History when the Country was overflowed by the Sea, he would evade that Way, and introduce his Notion of subterraneous Passages ; which is, as if a Mariner discovering an Island in some great Ocean, and finding some House on it, but no Inhabitants, should conclude that this House had there grown of itself, or else had been brought thither thro' the Air by some violent Hurricane, and there set down, (for I fancy a Hurricane might as easily carry a House three-score Miles thro' the Air, as subterraneous Passages convey the Sand, and *Amber*, of the Sea-Shore, to a Mountain three-score Miles in the Land,) and he should make this Conclusion, because he wanted a History of the Habitation of this Island by some Men. But (as I said before) we must allow the Author some Grains for his Kindness to his own Off-spring. But, as we have hitherto made him some Grains of Allowance for his Partiality for his Hypothesis of the *Minera arenaria*, and the subterraneous Conveyances, where he is forced to yield it may be Sea-Sand ; so we must now allow him some Drachms, or rather Ounces, where he would evade the *Minera lignea* of *Amber* ; for this *Minera* seems to spoil his *arenaria* : For, tho' almost all the other Authors do make this to be the chiefest, and most natural *Minera*, which affords, by much, the greatest Quantity, and the biggest, and most entire Pieces ; and tho' he agrees with them, by his own Experience and Observation, yet, since it would depose his *Minera arenaria* from the first Dignity, by one Salvo he evades all the Strefs of it against his *Minera arenaria*, by making it but one Species of the *Minera lutea* : For, he would have the Wood that is found, not ever to have been Trees, but only Clay so shaped, by he knows not what Cause. For he

says,

says, (p. 61.) after he has told the several Opinions of divers Authors concerning the Species of the Trees that compose the *Minera lignea*, *Verum parum interest scire cujus ligni præferat faciem, cum genuinum lignum non esse in Physicis demonstretur satis.* And so again, after he has more particularly examined the Words and Assertions of the most celebrated Authors, concerning this Opinion, and opposed them, as much as he was able, (which Answers, to me, I confess, seem very insignificant, and, at best, but Evasions) he says, (p. 182.) *Quare cum nec historia nec rationibus solide probari possit, succinum arborum esse succum, parum interest discrimen lachrymæ, gummi, & resinæ, hoc loco annotare & disquirere quo nomine convenientius succinum fuerit appellatum.* But, notwithstanding this, what he himself has observed and related, concerning this *Vena lignea*, seems as great an Argument against his own Opinion, as any can be brought. He says then of his own Observations, (p. 59.) *Diversimode contemplari contigit ad Craxtepellem totum montis jugum contactum quasi corticibus grisei coloris vidi. Superiorem enim faciem Soli expositam ita calor exsiccaret: remota vero hac parte extima piceæ nigredinis terra magnis quasi & levibus nitidisque crustis persitus concreta conspiciebatur; atque si cultro diffecabatur, quasi multos mollissimos cortices diffecuisse, secta præ se ferebat; introrsum versus vero soliditas compacta terra difficilem sectionem reddebat.*

THIS is his first Observation, which, how plainly it describes Trees, I leave any one, unprejudiced, to judge. First, They were found at the Top of the Mountain, where, in Probability, they had grown; and where, by the way, 'tis not very likely that there should arise a Fountain of *Bitumen*, or that the *Amber* should be conveyed thither by subterraneous Passages; and yet Plenty is there

dug out : And whilst he was there, he says, there was taken up *unum ghetalum succini* : What *ghetalum* signifies I know not. Next, How proper his Opening, or Dissecting of this Ground, as he calls it, does represent a rotten Tree, you may easily judge: For, first, he describes the Substance of the Bark, or Rind ; next, the sappy Parts of the rotted Tree ; and, lastly, the Heart, or solid woody Part of it.

HIS second Observation is this, (p. 60.) *Aliter ad Gross Hubenig venam ligneam cum fossorum operis conspiciere datum fuit. Mons erat arenosus, plane intermedium erat genus ligni quod putredo emollivisse videbatur, ut facillimo negotio bipalio instar molliissimæ terræ a fossoribus radi posset, nigro quasi carbonis colore infectum ; specie abirgno non absimile, imprimis cum in ejusmodi cortices circulares veluti deglubi poterat, & alias ejusmodi intersegmenta, sive lineamenta ostendebat : Alii querno comparant, sicuti & frusto ligni Spork, scilicet fragmenta quæ cum succino ejici postea dicendum erit, ejusdem generis credunt.* Read the Book, Pag. 61, 62, 63, 64, 65, and 66, to §. VIII.

THAT some of these Pieces of Gum have been found not quite petrified, but only so far as to have some Degree of it, yet to be mouldable like Wax ; Further, that the Country has been sometime overflow'd, and that the Remainders of the Sea have been left in several Parts of the Country : But, besides the Sea-Water, it seems to me, by several Passages in this Book, that I could quote, that the Land of *Prussia* abounds with these Kinds of petrifying Substances, rather than that that Country was the only Place where those Kind of Trees grew ; and, that it seems by the Differences of *Ambers*, found in very distant Parts of the Earth, that other Sorts of resinous Gums may be turn'd into *Amber*, if the petrifying Substances be afforded,

afforded, where such Gums do drop from their proper Trees : Now what is the true petrifying Substance of *Amber*, I have not Observations enough to determine, nor have I wherewith to defray the Charge of Experiments for that Purpose. Some Conjectures I have, concerning other Kinds of Petrifications, for there are many Kinds of that Operation, which I may, some other Time, discourse of, and, if I have Conveniency, shew some Experiments about it : 'Tis a Subject that deserves to be cultivated, for it will afford very much of Information in physical Productions, and 'tis, I conceive, much differing from the Sentiments of Authors I have hitherto met with, who have treated of it. But I fear, I have been too tedious on this Subject, and therefore shall say no more at the present, only I shall shew a Specimen or two of another Sort of Petrification, and those are of Chalk, which though from its Plenty, it be more vile, yet, for that very Cause, it seems to me to be well worthy a more serious and diligent Enquiry, to find out from what Substance that Body had its first Original, for by the Instances that I shall shew, it appears plainly, that it was a fluid Body before it became a solid ; and by other Instances also, it appears, that Flints were likewise so before they were petrified into Flints, and so several other stony Concretions, of which Subjects, little is to be found in natural Historians.

A third Discourse of Dr. HOOK's concerning Amber, on May 19, 1697.

SINCE I read some Discourses here the last Vacation, concerning my Conjecture about the Original of *Amber*, in which I endeavour'd, by many Arguments, to prove it to be a Petrification

faction of a vegetable Juice, or the resinous Gum of some Tree, I had Occasion to search into the *Acta Hafniensia* of *Thomas Bartholine*, for another Enquiry, and so accidentally met with some curious Observations of that learned Man, concerning this Subject of *Amber*; some of which I conceive, if not all of them, do much contribute to establish the Doctrine, or Opinion, which I endeavour'd to maintain.

THAT which I principally took Notice of is, the 57th Head or Section of the first Volume, for the Years 1671, and 1672. Published at *Copenhagen*, in the Year 1673. It contains an Account of Observations and Experiments about *Amber*; where, first, he relates, that the Diggers of the new Ditch, about the City of *Copenhagen*, met with Pieces of *Amber* of several Bignesses; and, which was very remarkable, the Diggers took Notice, that wherever they found these Pieces, they found them mix'd with the *Minera* of *Amber*, namely, the Bark or Rinds of Oak-Trees, with which it was not only mixed, but stuck, or glued fast to it, as is to be seen, says he, in the several Pieces which the Diggers have sold to divers curious Persons. There was also another Mineral, which was a black Wood, as if burnt, to which the *Amber* also stuck. I should, says he, have believed it to be some Sort of Bitumen, or black *Amber*, if the Smell of it had not made me of another Mind; for the ill Smell of it, when burnt, made me judge it to be the Remains of some Pieces of Oak. And yet *Camden*, says he, in his Description of *Whitby*, mentions such a black *Amber*, or Jet, to be found in *England*. The Passage in *Camden* is this; speaking of the Parts near *Whitby*, in the North-Riding of *Yorkshire*, he says, *Juxta hunc locum & alibi in hoc littore repertum est Succinum nigrum sive Geate, Gagatum aliqui esse existimant, quem inter*

rariores

variores lapides gemmasq; habuerunt veteres, Enascitur vero inter cautes ubi rimis debiscunt; Et priusquam expoliatur, colore est subrufo, Et æruginoso. Expolitum autem vere est, ut inquit Solinus, Nigro-Gemmeus, de quo Rhennius Palemon è Dionysio.

—— *Præfulget nigro splendore Gagates
Hic lapis ardescens austro perfusus aquarum,
Ast oleo perdens flammæ, mirabile visu,
Attritus rapit hic teneras, ceu succina frondes,*

*Et Marbodæus in suo de Gemmis Libello;
Nascitur in Lycia lapis Et prope Gemma Gagates,
Sed genus eximium fœcunda Britannia mittit;
Lucidus Et niger, est levis Et lævissimus idem:
Vicinas paleas trahit attritu calefactus,
Ardet aqua lotus, restinguitur unctus olivo.*

*Audi etiam Solinum. Gagates in Britannia plurimus optimusq; lapis; si colorem requiras, Nigro-gemmeus; si qualitatem, nullius fere ponderis; si naturam, aqua ardet, restinguitur oleo; si potestatem, attritu calefactus, applicita detinet. Thus far Camden; from all which to me it seems very probable, that the true Jet is a Kind of Amber, and differs from the common yellow Amber only in its Colour, which is very black; but 'tis found, as the other Amber generally is, only in small Pieces, most commonly in the Clefts of Stones, and which is further remarkable, where there are also found several other Substances, preserved by Petrification; for just before this Passage, about black Amber, in the same Page 485 of my Edition, he, mentioning other Remarkables of the same Place, says, *Lapides hic inveniuntur, serpentium in spiram revolutorum effigie, naturæ ludentis miracula, (quæ ut inquit ille)* (he means Bede) *natura cum veris Et seriis negotiis quasi**

quasi fatigata ludendo efformat. Serpentes olim fuisse crederes quos lapideus cortex intexisset. Hildæ autem precibus adscribit credulitas, tanquam illa commutasset, &c. I suppose he means the *Cornu-Ammonis* Stone, of which Kind, many are found in *Yorkshire* by several, but more particularly by Sir *Jonas More*, who assured me, he had seen one, and knew where to fetch it, which was full as big as the fore-Wheel of a Coach, which he promised to get, and convey to *London*, whenever he went into that Country; and that there was great Plenty of others of somewhat smaller Sizes, yet of the bigger Kind; divers of which Kind are in the Repository, though found in other Parts, as particularly in the Quarries of *Portland*, and at *Keynsham* in *Somersetshire*, by Mr. *Waller*; nor are these Kind of Petrifications in *Yorkshire* only about *Whitby*, but Multitudes also are found in *Richmondshire*, as the same Author, Mr. *Camden*, testifies, (*pag. mibi 489.*) *Incisis rupibus & montosa collum eminentia hæc regio fere tota eminet quorum convexa sunt alicubi, sunt satis herbida, &c. Montes plumbo, carbone fossili, necnon ære gravidæ, &c.*—Quod in eorum autem summitatibus ut etiam alibi, lapides nonnunquam fuerint reperti, cochleas marinas & alia aquatilia referentes, si non sint naturæ miracula: refusi in omnem terram sub Noe diluvii certa esse indicia cum *Orosio Christiano historico* judicabo. Sic enim ille scribit, &c. But to pass this by, which I have only taken Notice of, to shew, that about those Parts there are sufficient Indications of Petrifications of other Substances also; and thence we have the more Reason to conclude, that *Amber* also, both White, Yellow, and Black, are Petrifications also, and that the Colour may proceed, either from the particular Nature of the original Gum, or else from the differing Sorts of the petrifying mineral

mineral Salts ; for 'tis sufficiently known, that Oak turns to Black with a vitriolate Mineral, and to Red with an aluminous ; or that the Black may have been produced by the Effects of a subterraneous Fire there having broke forth, as Pitch and Tar are strain'd by the Power of Fire, in the artificial Making them, by burning of the Wood, out of which they are forced ; and as the vitrious Jet, of which we had formerly some Specimens here, presented by Sir *Robert Moray*, which were brought from the burning Mount *Hecla* in *Island* ; which black Substance was a perfect Glass, and, by melting of it in the strong Flame of a Lamp, I reduced several Pieces of it to clear transparent Glass, the Thickness thereof vanishing, by the keeping it for some Time melted in the hot Flame of the Lamp : But however this black *Amber*, or Jet, comes to receive such a Tincture, it seems plainly to me, to be of the same Nature with yellow *Amber*, and both of them very different from those Substances that are originally mineral, as *Asphaltum*, or other bituminous Substances, especially by their Lightness and Fineness of Texture, as their artificial Polish does plainly manifest. And *Bartholine* seems plainly to be convinced of the Truth of this Hypothesis by many Passages, related in this 57th Observation ; as particularly, that it has been left where it was found at *Copenhagen*, by the Sea ; and that all that Country has sometimes, formerly, been overflowed by the Sea. Next, That all *Amber* has been first soft, and, by Process of Time, indurated ; that, when soft, it was the Gum of some Tree ; and, while so, those several Substances were immers'd in it, which afterwards became cas'd up, and inclosed in the same Substance hardened, or petrified ; as, *Joh. Gobelius* had a green Frog so inclosed, and *Frederick III.* King of *Denmark*, had a Lizard after the same Manner : And *Monf. Picart*

was

was presented, by *Scholerus*, with the Cone of a Fir-Tree inclosed in the same Manner. *Non igitur dubitamus*, says *Bartholine*, *liquidam fuisse Resinam vel Lachrymam ex arbore profluentem, & vel sale, vel temporis diuturnitate in maris littoribus concrefcere & indurari*: Quamquam probabili ratione quoque, alii ex pingui bitumine in istam soliditatem compingi suspicentur. As to his other Trials about the Dissolution of *Amber*, mentioned in this 57th Section, I omit them, as affording little of Information pertinent to the Solution of this Query, Whether it owes its Original to a vegetable or mineral Substance? And pass on to the 122d Observation of his second Tome; where, upon the Occasion of some Objections made against his Supposition, by *Job. Dan. Major*, Professor in the University of *Kilee*, he has enumerated all the Observations which he conceives to be pertinent to the determining this Controversy.

1. THE Cone of a Fir-Tree included in *Amber*; my Friend *Sextus Scholerus*, Consul of *Copenhagen*, had.

2. I saw, at Mr. *Henry Monachen's*, my honoured Kinsman's, a Piece of *Amber*, composed of white, yellow, and green Parts, in which was included a Gnat, and some of the Moss of a Tree.

3. *Wigandus*, in his History of the *Prussia Amber*, relates, that he saw a green Frog, which is used to sit on the green Leaves of Trees, included in a Mass of *Prussia Amber*.

4. THE Sticking of Gumlac to its Sticks gives a Suspicion that *Amber* may stick in the same Manner; tho', being liquid at first, it may not stick to the Twigs, but drop down from them.

5. THAT most Gums, which flow out of Trees, do not carry with them the Impression of those Trees.

6. That

6. THAT those small Creatures, as Flies and Gnats, which are found in *Amber*, do pitch on such Parts of Trees where the Gum trickles down, and so are as likely there intangled in it, as in the Earth; where they do not only abscond, during the Winter Months, benumbed as 'twere, and half dead.

7. IF you believe *Tacitus*, Birds also have been found in *Amber*, whose Words, in the Book of the Manners of the Germans, are remarkable, and not disbeliev'd by any. *Succum tamen arborum esse intelligas* (says he) *quia terrena quædam atque etiam volucris animalia plerumque interlucent, quæ implicita humore mox durescente materia eluduntur. Fecundiora igitur nemora lucosque, sicut Orientis secretis, ubi Thura Balsamæque sudantur, ita Occidentis insulis terrisque inesse crediderim, quæ vicini solis radiis expressa atque liquentia in proximum mare labuntur, ac vi tempestatum in adversa littora exundant. Si naturam succini admoto igne tentes, in modum tedæ accenditur, alitque flammam pinguem & olentem; mox ut in picem resinamve lentescit: Thus far Tacitus.* Now, says *Bartholine*, If this Account be true, why should we doubt the former Arguments; especially, since the natural Historians, *Solinus*, and others, agree with him: Nor is the Fidelity of *Olaus Magnus* to be wholly rejected, tho' he had dreamt in some Things.

8. THE Barks of Trees are always found mingled with the *Amber*, where-ever it has been dug up with us.

9. THE Feathers of Birds have not been observed in *Amber*; because the Bird sits on the Branches, and not against the Body of the Tree, where the Gnats, Flies, and other small Insects do creep.

10. IN *Norway*, where the Pines, and other resinous Trees abound, there are found Lumps of Gums emulating *Amber*. The Inhabitants call it
a Stone,

a Stone, and my honoured Kinsman, *Job. Finchius*, brought hither one of those Lumps, which was a Kind of *Amber*; for it seem'd to be a light Stone, or a black Sort of Horn, which would kindle, and burn with Flame; but it stunk much: Otherwise, it seem'd a Kind of *Lignum fossile*; yet it did neither burn so readily, nor stink so much, as black *Amber*.

II. As to *Ambergreese*, which is brought from *Florida*, tho' it be doubted by me, whether it be made of the Sperm of a Whale, or the Semen of an Elephant, as *Ctesias* is said, by *Aristotle* in the 2d Book of the *Generation of Animals*, to assert; or of the Dung of certain Birds of the *Maldives*, which feed on odoriferous Plants, as *Ferdinando Lopez* conceives; or a Composition of *Lignum Storax*, *Aloes*, *Civet*, and *Laudanum*, as *Fuchsius* supposes; or a Kind of Bitumen ouzing out of the Bottom of the Ocean, as *Guliel. Du Val*, in his *Phytologia* asserts it; yet, I dare affirm, that it has the same Original as yellow *Amber*: For, there has been lately found some of it in *Prussia*; and, I cannot doubt, that there may be Trees found in the New World, yielding odoriferous Gums. Thus far *Bartholine*.

To whose Arguments I have only six of my own to add, which seem to me as convincing, if not more, than all these. And those are,

I. THAT it appears, by all the Relations we have of the finding of the yellow, black, or gray *Amber*, that they are never found in any very large Pieces; but only in such Lumps or Pieces, as may very well be supposed the Exudation of a Gum out of one or two Vents of the same Tree. Whereas, were they mineral, I see no Reason why they should not be found in as great Masses as *Asphaltum*, *Canall*, *Scots-Coal*, or *Bitumen*, are usually found.

2. THAT

2. THAT all Kinds of *Amber*, of whatever Colour, whether white, yellow, green, or black, are very light, and almost of the same Weight with Water, being but $\frac{1}{12}$ Part heavier; so that it will but just sink: Whereas those other Substances, as *Canal*, or *Scots-Coal*, are very heavy generally, and more than double the Weight of Water.

3. NONE of these Substances do seem to have any peculiar Figure, as to be formed into plated or prismatical Bodies, as those Substances I last mentioned have, especially such as have Transparency, as *Talk*, *Selenites*, *Chrystals*, &c. and the Uniformity, or Continuity, of the Mass, plainly proves, that it was perfectly united, whilst yet fluid, and not form'd by ChrySTALLIZATION, or Concretion, as Salts out of Brines, or Sugar-Candy out of Syrups; or petrified Spars, or Chrystal, out of Sea-Water.

4. THAT Turpentine, by being buried in the Earth, for some considerable Time, will yield, upon Distillation, an Oil perfectly resembling Oil of *Amber*, for Colour, and Smell, as was above 30 Years since proved by Dr. *Daniel Cox*.

5. THAT there is no other mineral Substance that is so light and rarified as this, which will take and receive so curious a Gloss, and Polish, as this will receive; whereas, of vegetable Substances, we have Instances enough in hardened Gums, &c.

6. THAT there are Instances enough to be found of the Petrification of vegetable Substances; and so this cannot be look'd on as a Singularity in the Parts.

THESE, I confess, to me seem to be *Experimenta Crucis*, as the Lord *Verulam* says; and I very much doubt, whether there can be any one Argument as convincing, as each of these, for the contrary Opinion. However, I leave every one to judge of both as he shall see most reasonable,

Observations concerning the
and propound these Arguments only, as those
which have inclin'd me to be of this Opinion.

THE Weight of a Piece of *Amber* in the Air
is, ————— 2443 grs.

AND in Water ————— 202.

AND is to Water near as $1\frac{82}{100}$ or $\frac{8}{100}$ Parts.

Amber to Water is as 12 to 11.

2443 ($1\frac{82}{100}$.)

202

—————
2241

Observations concerning the Refractions of the Atmosphere.

THESE *Observations*, I conceive, were the
Reverend Mr. Lowthorp's, being written in
his Hand. They bear Date February 14, 1698-9,
and precede the Experiment he made at the Request
of the Royal Society the Month following, March
28, 1699. Of which an Account is given in Phil.
Transact. N^o 257.

W. DERHAM.

THE Doctrine of Refractions does so sensibly
affect almost all Astronomical Observations,
that, till that be well establish'd, these will be too
weak to support the Conclusions which are gene-
rally inferr'd from them. At present, this Do-
ctrine is involv'd in this one great Uncertainty,
viz. The Air being no uniform Fluid, the Rays of
Light are not refracted in any one terminated Su-
perficies, but continually into a Curve; and it is
not easy (if possible) to determine the Nature of
that Curve, till we know the Proportion of the
Powers

Powers of Refraction in the several Densities of the Atmosphere.

THAT the Attempts, hitherto made by Astronomers, are not satisfactory, I think, will be allow'd, when it is consider'd, that, if (according to the receiv'd Opinion) the Distance of the Moon be about 60 or 61 Semidiameters of the Earth, and the Horizontal Refraction above 30', the Moon at an Eclipse passes thro' the Focus of the Atmosphere, or very near it; and that every distinct Point of the Moon's Hemisphere is illuminated (even in the Middle of a Central Eclipse) by Rays flowing from every Point of the Sun's Hemisphere, which is directly contrary to the Nature of an Eclipse. We seem, therefore, under a Necessity, either to remove the Moon in the Plenary System above 20 Semidiameters nearer to the Earth, that it may fall into that Part of its Shadow, which the Duration of Central Eclipses require; or to form a new Theory of the Refractions of the Atmosphere. I am sure the first would so far confound our receiv'd Astronomy, that he would be a very bold Man who durst venture to maintain such a Paradox: But I hope the Proposal of the following Experiment, relating to the latter, will be excused; because it may, perhaps, be of Use towards the removing this great Doubt.

UPON an Air Pump place a small Receiver of Copper, having, on each Side, an even, well-polish'd, flat Glass, and moderately thin: Let their Angle of Inclination to each other be about 65 Degrees, *viz.* with a Telescope, thro' these Glasses, whilst the Receiver is full of Air, a Thread placed at least 40 Foot from them; and, as the Pump reduces the Air to several Degrees of Rarity, (which may be measured by a Barometer inserted into an End of the Receiver) remove the Thread, till it appear

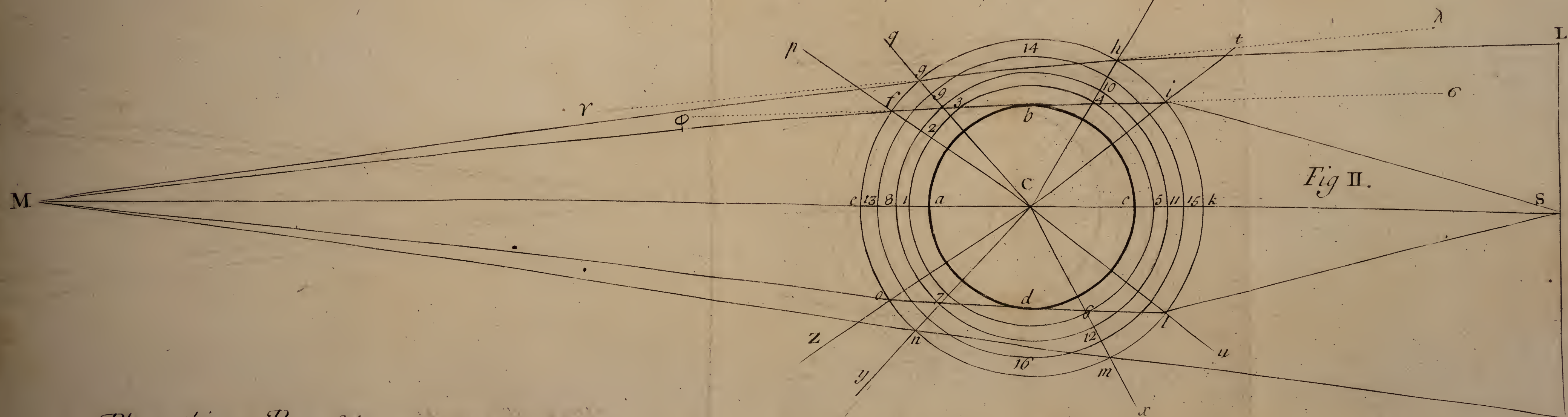
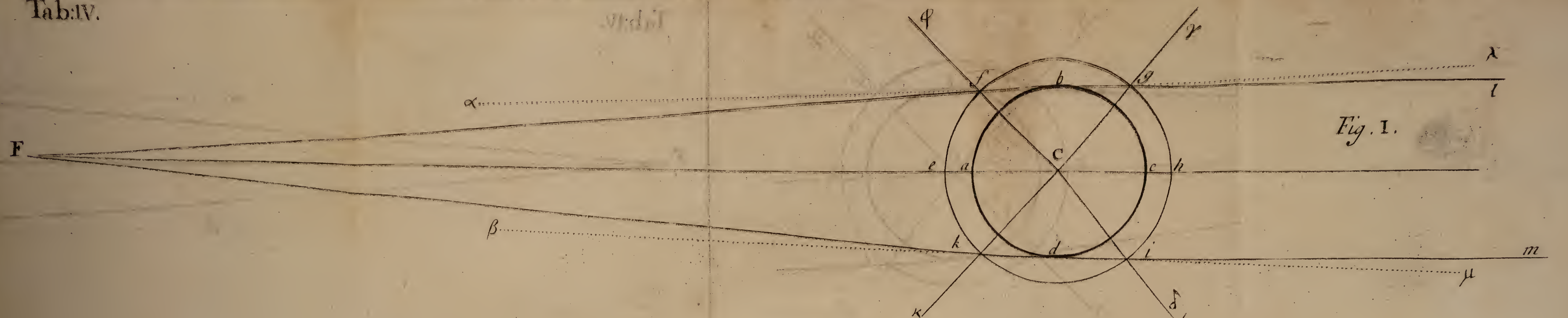
in the same Place in the Focus of the Telescope, as at first. By this Means the Angles of Refraction, and Incidence, may be easily found, and more certainly determin'd, than any other Way yet publick. And if this Experiment be repeated in several Temperatures of the Air, I doubt not but such a Theory of Refractions may be establish'd, as may be depended upon, to confirm, or reform, Astronomy.

P E R H A P S this Experiment may be made, more conveniently, by filling the Receiver with Quicksilver, and pumping it out ; which will leave the Receiver absolutely void of Air.

T H I S Experiment must be made with great Nicety and Exactness : For, according to the common Tables of Refraction, this Inclination of the Glasses to each other (one of them being at Right Angles to the Axis of the Telescope, and may be its Object Glas) will not produce, for the Angle of Refraction, above $4'$.

T H E Charge will not be above two Guineas, or two and an Half, if made with Quicksilver ; and the Materials will be worth most Part of that Money again, whenever disposed of : But, if the Air Pump can be so fix'd, as not to shake, or change its Situation with Working, the Charge will be very little.

LET $abcd$ be the Superficies of the Earth, and $efghik$ of the Air, having a common Center C . Then suppose $egim$ to be a Cylinder of Light flowing from a small Part of the Sun, equal to the Earth, and the extreme Rays lg and mi refracted (by their Immersion into the Air) towards the Perpendiculars γC and δC becoming thereby Horizontal at b and d ; and by their Emer-
 sion out of Air, from the Perpendiculars ϕC and αC , and to intersect and the Axis of
 the Cylinder of Light at the Focus F . Let the
 Angles



Place this at Page 340.

S. Parker Sculp^t.

Angles of Horizontal Refraction, towards the Perpendicular $\lambda g l$, and $\mu i m$ be $30'$, then the Angles of Horizontal Refraction, towards the Perpendiculars $\alpha f F$, and $\beta k F$, will be also $30'$, and then the Angles $f F C$ and $k F C$, will be $60'$, or 1° . And then the Semidiameter of the Earth, $b C$, subtending that Angle (and near) is near $\frac{1}{8}$ Part of the Distance of the Focus $F C$, and therefore the Moon's Place at an Eclipse.

Fig. II. LET $a b c d$ be the Superficies of the Earth, and let the Concentric Circles 1, 2, 3, 4, 5, 6, 7, and 8, 9, 10, 11, 12, and 13, 14, 15, 16, and $e f g h i k l m n o$, be supposed so many distinct Densities of the Air, and $L L$ the Diameter of the Sun. If the Rays $S i$ and $S l$, flowing from the Center of the Sun S , be refracted by their Immersion into Air, towards the Perpendiculars $t C$ and $u C$, and become Horizontal at b and d ; and be refracted by their Emersion from the Perpendiculars $p C$ and $z C$, and intersect each other at M ; then the Parallax of the Sun $i S C$ (suppose) $48''$, being subtracted from the Horizontal Refraction, by Immersion $\sigma i S = 30'$, and the remaining $29' 12''$ being added to the Horizontal Refraction, by Emersion $\phi f M = 30'$, the Sum is the Angle $f M C = 59' 12''$; therefore the Semidiameter of the Earth, $b C$, subtending this Angle (and near at Right Angles to $M C$) is more than $\frac{1}{8}$ Part of the Distance of this Intersection, and therefore not far from the Moon's Place in the Middle of a Central Eclipse.

FROM hence 'tis obvious, that, if the rarer Air have a less Power of Refraction, the Rays $L R$ and $L m$, flowing from any Parts of the Sun's Hemisphere, (as L and L) may fall upon some Part of the Atmosphere, where the Angles of Refraction $\lambda b L$, and $\gamma g M$ (being less $\sigma i S$) will direct it to the same Point M . Therefore M is illuminated

by Rays flowing from every Part of the Sun's Hemisphere: And therefore, if the Moon be at this Distance, every distinct Part of its Hemisphere will be illuminated by Rays flowing from every Part of the Sun's Hemisphere.

I am in too much Haste to be exact, either in the Exceptions, or Reasonings, but I hope thus much will sufficiently appear, that it is very difficult to account for the Phases of the Moon upon the receiv'd Hypothesis, and that further Satisfaction is to be wish'd, which is all the Use I design'd to make of them.



*The Sun's Eclipse, as it was observed at
Canterbury, in the Year 1699, September
the 13th, in the Forenoon, by Mr. STEPHEN
GRAY.*

| Phases. | Digits Eclip- fed. | Time by the Min. Watch Correct. | What more was worthy Observation. |
|---------|-----------------------|---------------------------------------|--|
| 1 | 0 | 8 12 | The Eclipse began. |
| 2 | 1 | 8 18 | |
| 3 | $2\frac{1}{8}$ | 8 24 | |
| 4 | 3 | 8 29 | |
| 5 | 4 | 8 34 | |
| 6 | 5 | 8 39 | The Center of the Sun is eclipsed. |
| 7 | 6 | 8 47 | |
| 8 | $7\frac{1}{4}$ | 8 55 | |
| 9 | 8 | 9 0 | |
| 10 | 9 | 9 8 | |
| 11 | 10 | 9 17 | The greatest Obscuration. |
| 12 | $10\frac{1}{2}$ | 9 24 | |
| 13 | 10 | 9 30 | |
| 14 | 9 | 9 38 | |
| 15 | $8\frac{1}{2}$ | 9 41 | |
| 16 | 8 | 9 45 | The Center of the Sun is emerged. |
| 17 | $7\frac{1}{2}$ | 9 49 | |
| 18 | 7 | 9 53 | |
| 19 | $6\frac{1}{2}$ | 9 57 | |
| 20 | 6 | 9 59 | |
| 21 | 5 | 10 7 | Cloudy. Cloudy yet. |
| 22 | | 10 9 | |
| 23 | | 10 20 | |
| 24 | 3 | 10 23 | |
| 25 | 2 | 10 29 | |
| 26 | 1 | 10 34 | The End of the Eclipse. Latitude of Canterbury $51^{\circ} 15'$ |
| 27 | 0 | 10 42 | |

By comparing these Observations of Mr. GRAY with others of the same Eclipse, I find the Difference between the Times of Mr. GRAY's Observations at Canterbury, and those of other Places lying E. and W. of Canterbury, to be as in this Table.

| Places where Observations were made. | By the Beginning. | | By the Middle. | | By the End. | | Bearing. |
|--------------------------------------|-------------------|------|----------------|------|-------------|------|----------|
| | Min. | Sec. | Min. | Sec. | Min. | Sec. | |
| <i>Oxford,</i> ————— | | | 17 | 00 | 17 | 51 | W. |
| <i>Paris,</i> ————— | 3 | 00 | 3 | 00 | 3 | 00 | E. |
| <i>Greenwich,</i> ————— | | | | | 8 | 30 | E. |
| <i>Hervelsing,</i> ————— | 43 | 00 | | | 49 | 00 | E. |
| <i>Nurenburg,</i> ————— | 45 | 14 | 53 | 54 | 51 | 56 | E. |
| <i>Ciza,</i> ————— | | | | | 53 | 00 | E. |
| <i>Leipsick,</i> ————— | 59 | 00 | | | 56 | 30 | E. |



Observations on the Nostock; proving it to be a real Plant. By Mons. Geoffroy, Jun. From the Memoirs of the Academie Royale des Sciences, June the 6th, 1708. Mem. Edit. Amst. p. 293.

THE Nostock of Paracelsus, which he also sometimes calls *Carefolium*, and which other Writers name *Cæli Flos*, *Cæli Folium*, *Flos Terræ*, looks like a Kind of Jelly, sometimes clear and transparent, sometimes greenish, trembling when fresh. It is found often in the Summer Months between the vernal and autumnal Æquinox, before Sun-Rising, in Fields, and on dry sandy Grounds, after a Shower of Rain. After the Sun is up, the Heat of his Rays dries it up, so that there remain only the Skins, or Membranes, of it, of a brown Colour.

THERE is a Doubt, as to the Production of this Substance: Some would have it, that it falls from above, like a Dew; and that it is the Excrement of the Stars: Others look upon it as a Product of the Earth, and a Sort of Plant.

MONS. Magnol, in his *Botanicum Monspeliense*, names it, *Muscus fugax, membranaceus, pinguis*. Mons. Tournefort, in his *Treatise of the Plants about Paris*, calls it *Nostock Ciniflorum*. I take these two to be the only Botanists who have taken Notice of it.

Mr. Ray saith nothing of the Nostock, as a Plant: But if it be the same with that Jelly which we call Star-fall (which many imagine to be the Substance of those Meteors, that go by the Name of Falling-stars, that shoot cross some Part of the Heavens, or seem to fall down in the Night) if,

if, I say, the Nostock be this Jelly, then it is what Mr. Ray takes to be vomited up by Crows, that have overgorged themselves with Frogs.

W. DERHAM.

I THOUGHT good to shew it to the Academy, in its different Ages, that they might be the better assured, that it is a Substance produced by the Earth; and that it is joined to it, or communicates with it, by many small Roots, or Fibres.

THE Embrion of this Plant, at first, looks only like a little, soft, fleshy Tubercle, full of little Inequalities, like those on some Strawberries. It is of a green-brown Colour; it grows brighter, or lighter-coloured, as the Skin grows larger; and, at last, this Membrane seems quite opened, and spread upon the Ground, on which it sometimes leaves the Marks impress'd by it.

WHEN the Plant is arrived to this State, it keeps so, as long as the Season remains wet; nor does it dry up, or wither, till the Sun and Wind dries and parches the Earth; and, by Consequence, deprives it of Nourishment.

I HAVE observed it, in its natural State, to turn up, and bend, usually lengthways; and, it seemed to me, that the two Ends, coming afterwards to meet and join, made a Kind of membranous Bag, or Packet.

IN the Year 1667, Mr. *Duclos* brought to the Academy a clear insipid Water, distill'd from the *Nostock*, which turned white, with a Solution of corrosive Sublimate.

IN 1678, Mr. *Bourdelin* made a more exact Analysis of it; which afforded him a great deal of Phlegm, a considerable Quantity of a volatile Salt, either concrete, or dissolved in the Liquor, and a foetid Oil.

THE Analysis, I have made of it, agrees very well with that of these Gentlemen; for, at first, I drew from it a clear, tasteless Water, which turned white with the Sublimate, and turned Syrup of Violets green. The other Liquors, I drew from it, confirmed what I have remaked of the first. Lastly, I gained from it a fine, volatile, concrete Salt, chrySTALLIZED on the Sides of the Recipient; a volatile, urinous Spirit; and a foetid Oil. A Lixivium, being made of the Caput Mortuum calcined, afforded but a very little fix'd Salt, and that mix'd with an earthy Matter: It turned a Solution of corrosive Sublimate a little yellowish, and made Syrup of Violets green.

IF this Plant be put to ferment of itself, in a close Vessel, it rots and dissolves into a very stinking Liquor; which, at the End of 20 Days, looks red; and, at 10 Days more, blue.

I HAVE observed, that these two Sorts of Liquors, even after a considerable Time, were the one acid, the other alkaline. The red Liquor had no Effect at all on the Solution of Sublimate, and reddened Syrup of Violets but a very little: The blue Liquor turned white, with a Solution of Sublimate Corrosive, and made the Syrup of Violets green.

GREAT Power and Vertue is attributed to this *Nostock*. The Common People of *Germany* use it to make the Hair grow thick. It is thought to be an excellent Remedy for Cancers and Fistula's. A *Swiss* Physician, having powder'd it, gave two or three Grains of it to ease inward Pains: The same made Use of it externally for Ulcers.

IT is a Part of the Composition called *Spernium compositum Cnoeffelii pro Principe van Eggenberg*; the Description of which may be seen in the *German Ephemerides* for the Year 1676, amongst the Secrets of *Cnoeffelius*.

THE *Chymists* imagine that the *Nostock* contains the universal Spirit. They draw from it a soft Spirit, (*Esprit doux*) to which they attribute great Vertues; and this they believe to be the radical Dissolver, or *Menstruum* of Gold.

THEY distill the Water off by the Heat of the Sun only, or of a gentle Fire, otherwise it rises very fast. This Water is reckoned a very gentle, mild Dissolver.

IT is reported that it eases Pains admirably, and cures the most stubborn Ulcers.

Concerning the Burning-Glasses of the Ancients, from the History of the Academie Royale des Sciences, for the Year 1708. With some Remarks. By RIC. WALLER, Esq. &c.

ALTHOUGH the *Academy* does not propose to make Enquiries after Antiquities; and is rather employed in Discoveries of Matters, as they are at this present, than to know what was formerly thought of them, or what Additions may be still made to the Arts, than what has been already practised; yet in it there was a considerable Regard made to *Monf. de la Hire's* Remarks, That *Burning-Glasses* were not unknown to the *Ancients*.

THAT they knew the Use of Burning Mirrors, or *Specula Ustoria* by Reflexion, is unquestionable; since some Historians have related, that *Archimedes* made Use of these for setting on Fire the Enemies Ships, in the Siege of *Syracusa*; and though they attribute a Power impracticable to them, yet it proves, that at least they were known to them.

BUT it is certain, these Mirrors were of Metal, and concave, and had their Focus by Reflexion: And it is a common Opinion that the Ancients knew nothing of Burning by Refraction, by convex Glasses.

Monf. de la Hire has found this Invention in a Passage in the *Clouds* of *Aristophanes*, not strain'd, or far-fetch'd. *Strepsiades*, a stupid old Fellow, tells *Socrates*, That he had found out an excellent Invention not to pay his Debts: The Words are in *Act* the II^d. *Scene* the 1st. towards the End.

THE *French* Author having omitted to give them in the *Greek*, I shall supply that Omission; and the rather, because I am of Opinion there is a Mistake in the *French* Translation, which I shall observe by and by.

Strepsiades. Ἦδη παρὰ τοῖσι φαρμακώλαις τὴν λίθον ταύτην ἐώρας τὴν καλὴν τὴν διαφανὴ ἀφ' ἧς τὸ πῦρ ἀπτεισι. *Socrates*. Τὴν ὕαλον λέγεις; *Streps*. Ἐγώ γε. *Socr*. Φέρε, πὶ δῆτ' αἶν; *Streps*. Εἰ ταύτην λαβὼν, ἐπότε γράφοιτο; * δίκην ὁ γράμματ' ὧς, Ἀποτέρω εἰς ὧδε πρὸς τὸν ἥλιον, τα. γράμματα ἐκπῆξαιμι πῶς ἐμης Δίκης. *Socr*. Σωφῶς γε, νῦν πὰς Χάριτας. *Streps*. Οἰμ' ὡς ἥδομαι, ὅτε πεντετάλαντον διαγέγραπται μοι δίκη.

I shall give the *Latin* Translation of this Passage, by *Nicodemus Frischlinus*, to which I shall add the *French*, and lastly my own.

Streps. Vidistin' apud Unguentarios & Alistas, lapidem illum pulchrum & pellucidum, unde Ignem accendunt? *Socr*. Num Vitrum dicis? *Streps*. Uti-que. *Socr*. Quid cum illo ages? *Streps*. Si scriba mihi scribat dicam, Ego procul stans, ad hunc modum ad solem, vitro delevero Literas intentæ mihi Dicæ. *Socr*. Sapienter, ita me Gratia ament! *Streps*. O gestio. Dicam quinque Talentorum esse expunctam mihi.

Fr. Str. *As-tu vu chez les Droguistes cette belle Pierre transparente, avec quoi on allume du feu?*
 Socr. *N'est-ce pas du ver que tu veux dire?* Str.
Justement. Socr. *Et bien, qu'est-ce que tu en feras?* Str. *Quand on me donnera une Assignation, Je prendrai cette Pierre là, & me mettant au soleil, Je ferai fondre de loin toute l'Ecriture de l'Assignation.*

I shall render the Greek Words thus:

Streps. *Hast thou seen at the Apothecaries that fine transparent Stone, with which they kindle Fire?*
 Socr. *Doeſt thou ſpeak of the Glaſs?* Str. *Yes:*
 Socr. *Bring it: What then?* Str. *When the Attorney hath written an Action againſt me, I will take this Glaſs, and ſtanding at a Diſtance, in this Manner, againſt the Sun, I will efface the Letters of my Action.* Soc. *Cunningly done, by the Graces.*
 Str. *O! How I rejoice, that the five Talent Action againſt me is defaced.*

I ſhall here only obſerve, that this was indeed to be performed by the Rays refracted through a Glaſs Body, in which I agree, with this Gentleman: Yet, I am of Opinion, it does not come up to a full Proof, that the Ancients knew any more than the Uſe of Spheres, for collecting the Rays, and not the Way by Lenſes, which I take to be a modern Invention; but of this more hereafter. To proceed then with the Tranſlation.

It appears plainly, by this Paſſage, that the Writing was graved in the Wax, which covered a more ſolid Body. That the Glaſs, which did light the Fire, and melted the Wax, was not a Concave; for altho' ſuch a Figure would have its Focus by Reflexion, yet, that being neceſſarily made upwards, would have rendered its Uſe very improper, and unfit for the common Uſe of lighting the

Fire;

Fire; and it would have been necessary to have had the Deed held up in the Air to have effaced the Writing; which would be an unnatural Supposition, whereas, with a convex Glafs, which throws the Rays downwards, they may be directed, where one pleases.

THE Scholiast, upon this Place of *Aristophanes*, says, It was a round, thick Glafs, made on purpose for this Use. This they rubb'd with Oil, and heated it, to which they fitted, or brought near, a Match, (for the *Greek* Word here is equivocal) and after this Manner the Fire was lighted.

I do not well understand what the Oil was for, unless it were to polish the Glafs; but, be that as it will, what is sufficient here, he conceiv'd this Glafs to be convex, and that in his Time, much later than *Aristophanes*, they used such Glasses to kindle a Fire.

I have no Design here to make a learned Dissertation, in which it were a Shame to let any Passage of Literature escape. I shall only remark that *Pliny*, in his 36th and 37th Books, speaks of Balls of Glafs, and Balls of Chrystal, which, exposed to the Sun, burn'd the Cloaths and the Flesh of sick Persons, which needed Cauterizing. And *Lactantius*, in his Treatise *de Ira Dei*, says, That a Ball of Glafs, fill'd with Water, and held in the Sun, would kindle the Fire, even in the greatest cold Weather. Here then we see the Effects of convex Glasses undoubtedly proved.

BUT if they knew that they would burn, how came it to pass that they did not also know they would magnifie Objects? For it is hard to be imagined, that an Invention so entertaining and useful, and withal, so simple and easy, should ever have been lost, even in the greatest Barbarousness of any Age; and all History fixes the Origin of magnifying Glasses about the End of the 13th Age,

Age, when the Use of Spectacles began to be discovered. If the *Greek* or *Latin* Philosophers had known this Augmentation of Objects, would they not have made Mention of it very frequently in their Writings, and several Metaphors, and Allusions to it, would have been brought into their Language. It is true, there are two or three Passages in *Plautus*, which seem to hint at the Use of Spectacles; which yet, more nearly considered, do not at all prove it. We will not insist upon them to avoid a Literature, to which I am a Stranger.

WHENCE came it then, that the Antients were ignorant of the chief Use of Burning-Glasses? First, The false Ideas, the Philosophers had of Vision, might contribute to it. They thought, that Vision was either caused by an Emanation of I know not what Sort of Substance, which came from our Eyes, and went in Quest of the Objects; or, by little Representations of the Objects, in Miniature, which came from them, and sought out our Eyes: All their Difficulty lay, in which of these two to choose, both equally false; they had no Suspicion of Pencils, of the Rays, nor of our Focus's; and, by consequence, they could see no Agreement between a Burning-Glass and the Manner of Vision, so that the one of these could not lead them to the other. Besides, it seems, that it was with Balls of Glass, solid, or fill'd with Water, that they burnt any thing; and Dioptricks demonstrate, that the Focus of a Sphere of Glass is at the Distance of half the Radius; so that if these Balls, or Spheres, had been six Inches Diameter, which is the most they could be, the Object to be magnified must have been placed at one Inch and half to be perceived to be magnified; and it is natural, and almost necessary, that when any one had look'd thro' these Glasses, he would have
look'd

look'd only at distant Objects, which, instead of appearing bigger, wou'd only have looked confus'd. A defined and distinct Augmentation of distinct Objects requires either very large Spheres, (which is impracticable, nor ever put in Use, or of Portions of large Spheres, as is now practis'd with great Success) which cou'd scarce ever be found out by Chance, nor easy to be invented by Reasoning.

BESIDES, they must have known how to have wrought, and ground their Glasses as we do; and, in all likelihood, the Ancients knew only how to blow their Glass, to make Vessels of it. It is no strange Matter, therefore, that their Knowledge of *Burning-Glasses* carried them no farther: It is more strange, that from the Use of Spectacles, to the Invention of Telescopes, there should be an Interval of 300 Years. Every Thing goes on slowly with us; and, 'tis possible, we are at this Time on the Brink of some important Discovery, which may be surprizing, one Day, that we did not find it out.

THUS ends this ingenious Gentleman's Discourse, to which I shall beg the Freedom to add some few Remarks on the same Subject, or nearly related to it, partly in Confirmation, and partly, as I take it, in clearing the Matter, and setting it in a true Light, without, in the least, pretending to Literature or Criticism.

IT seems then to me, in the first Place, that *Monf. de la Hire* would insinuate, that the Ancients knew not only Spheres burning at a 4th of the Diameter, but such Burning-Glasses as would have their Effect at a considerable Distance; since he translates the Greek Word *Ἀποτερεῖν*, *De loin, je ferai fondre de loin*; as likewise the Latin Word is *Procul*. This Word I rather *English*, at a Distance; which Sense, I take it, the Word will more truly

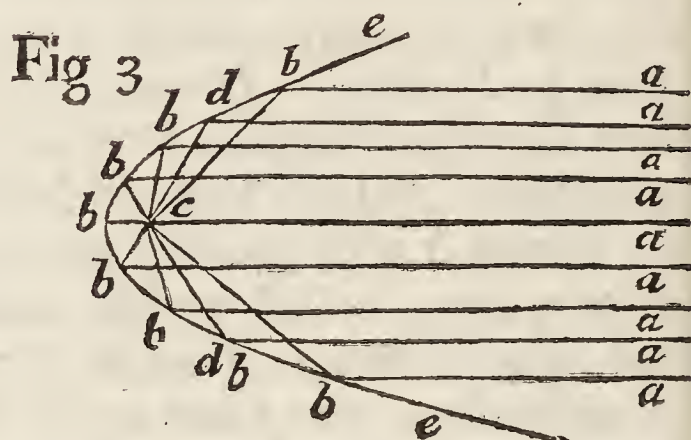
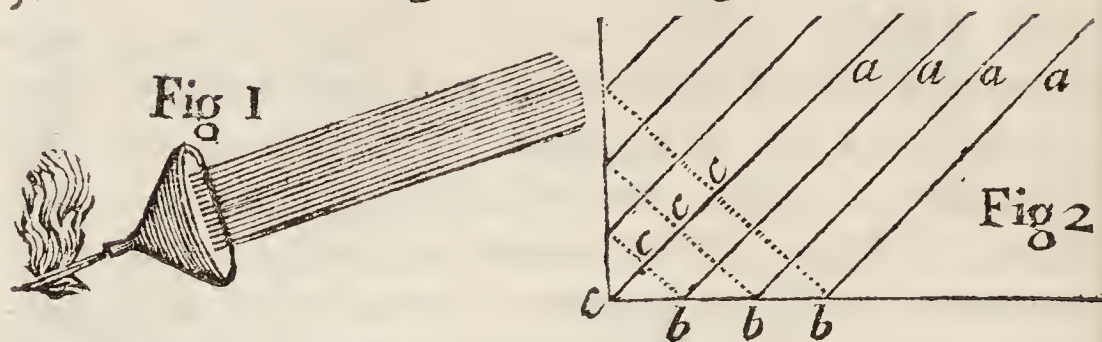
bear in this Place. So that by this Passage, it is not necessary the Glass should burn at any remarkable Distance from the Writing on the Obligation, provided it did not touch it; which I take the Meaning to be here by *Ἀποτέρω*, *Longius*, at a Distance, or farther off. So that a Sphere of Glass might do all that was requisite in this Case. Besides, if it should be urg'd that this could not be done, when the Scrivener was present, without his taking Notice of it. I reply, Neither was it: And if it be remarked, that the whole Design of the *Nubes* of *Aristophanes* being only to ridicule *Socrates*, it was proper enough to bring in an old Coxcomb boasting of an Invention for doing what indeed it would not perform; so the old Man, having seen a Fire kindled with a Globe of Glass, never considering the Distance requisite, might foolishly think it would do so at any Distance.

T H A T the Ancients had several Ways of kindling the combustible Matter placed on their Altars, without making use of common Fire for that Purpose, might easily be shewn, were it requisite, or to the present Purpose; which it is probable the Priests made use of, to raise the greater Admirati-on and Devotion in the ignorant and superstitious Beholders. The most solemn was that of the re-kindling the Vestal Fire, when it happen'd to go out.

T H A T the sacred *Vestal* Fire was continually kept burning, with great Care, by the *Vestal Virgins*, is certain; and if at any Time it happened to be extinct, the Virgin, to whose Care it was at that Time committed, was severely whipp'd, (*Flagris cæsa Vestalis*) by the *Pontifex Maximus*; which Damage and Loss was not to be repaired, by making use of any common or culinary Fire to re-kindle it. A particular Account how this was done, *Dionysius* somewhere says, he wrote him-self;

self; which, as *Justus Lipsius* observes, must have been in some of those Books of that Author, that are lost, (*Lips. de Vesta & Vestal. Syntag. cap. 8.*) The same *Lipsius*, out of *Festus*, cites this Passage, *Tabulam fœlicis materiæ tam diu terebrare mos erat, quousque acceptum ignem cribro æneo Virgo in ædem ferret.* Which Method of setting Wood on Fire is more clearly express'd by *Aristotle*, Lib. 3. *De Cælo.* *Ignem e lignis excutiunt, alterum lignorum tanquam terebram, in altero circumvertentes:* Which Way of setting Wood on Fire, by boring it with another pointed Piece of Wood, *Lipsius* says, is still in Use among the Natives of the *West Indies*. This *Terebra*, or Borer, *Theophrastus* says, was often made of Laurel, and the other Piece to be bored of Oak.

Plutarch mentions another Way of re-lighting this Fire. *Si quando extinctus ibi sacer Ignis: negant eum fas esse ex alio igne accendi, sed novum parandum eliciendumque ex ipso sole: quod faciunt scaphiis sive vasculis, quæ parantur ex latere trigoni rectanguli, quod duo latera æqualia habeat, divergunt autem ex circumferentia in unum Centrum. Cum igitur soli opponuntur, ut radii ejus in ipsum centrum cogantur & implicentur, aere attenuato, fomenta levissima & siccissima apponunt, quæ facillime per renixum & reflexionem concipiant accensum ignem.* This Passage of *Plutarch's Lipsius* attempts to illustrate, by a Sort of Funnel, whose Sides meet at Right Angles in the Bottom, which he calls the Center of it, and represents the Contrivance by a Figure. (See *Fig. 1.*) But either *Plutarch* did not well understand the Matter himself, or *Lipsius* has mistaken his Meaning: For a Vessel, so made, will never throw the Rays of the Sun into a Center, or Point; it will indeed reflect the parallel Rays into a Line, (as in *Fig. 2.*)



where the parallel Rays of the Sun are reflected, into the Line aC , in the several Points $c c c$, &c.

POSSIBLY this Vessel (if any such was used by the Ancients) was of a parabolic Figure, as (Fig. 3.)

WHICH reflects all the parallel Rays ab , ab , into the Focus at c , and the parabolic Sides of the Vessel appearing, for a great Part, *viz.* from d to e , very like strait Lines, *Plutarch* might take them for such, which made him call it a Rectangular Triangle; whereas it was really a parabolic concave Vessel, made by the Section of a Rectangular Cone.

As to this *Vestal Fire*, there is a Passage related by *Dionysius*, (*Lib. 2.*) concerning the *Vestal Æmilia* something observable. Scilt. *Hæc dicens, & e vesie linea fasciam abstrahens, qua cinctâ erat, dicunt illam post orationem jactasse in aram, eque frigido cinere, quod longe antea fuit absque scintilla, magnam per linum exiisse flammam, &c.* This Passage shews plainly, that the ancient Priests knew how to raise a Fire, nay, Flame, out of appear-

ingly

ingly cold Ashes, since there had been not so much as a Spark of Fire on the Altar for a long Time; whence, it seems, they then knew the *Phosphorus*, or something of the same Nature, with which the Linnen Fillet was rubb'd over, and which the undiscern'd Warmth of the Ashes set on Fire, and possibly some other Chymical Preparation might be concern'd in producing this Flame; which, being kept as a Secret among the Priests, might well raise Wonder in the Beholders. They had likewise several earthen Vessels, for the Fire, on the same Altar; *Et æternos Vestæ focos fictilibus etiamnum vasis contentos*, &c. Valer. lib. 5. cap. 4.

Onuphrius Panvin. de civitate Romana, cap. 29. (Gr. Vol. II. p. 228.) speaking of the Vestal Fire, has these Words; *Ignem amissum nequaquam decebat ex altero igne sumere; sed maximis precibus Numen Vestæ placantes, multis sacrificiis novum ex Solis radiis eliciebant, pura & immaculata flamma, ex lagena aqua plena solis splendori opposita, accensa*. *Onuphrius* does not quote his Authority for this Way, by a *Lagena*, as he calls it, placed, as he expresses it, opposite to the Sun's Rays, *Ex lagena aqua plena solis splendori opposita, accensa*; fired by Means of a *Lagena*, fill'd with Water, and placed opposite to the bright Rays. As to what the Figure of the *Lagena* of the Ancients was, I shall give my Thoughts presently; only first I must observe, that *Onuph. Panvin.* had no clear Notion of what he has here written; he tells us, that this Vessel (whatever its Shape was) was fill'd with Water; then its Use must have been to refract, and unite the Rays transmitted thro' it; for which Reason it was not *opposita splendori solis*, but *interposita*, in the same Manner as Burning-Glasses by Refraction.

As to the Figure of the *Lagena*, I find, by a Passage in *Pliny*, that it had a Neck, *Lib. 28. cap. 11.* where treating of Remedies for a Pain in the Ear, amongst others, he mentions Goat's Urine, &c. heated in this Vessel, the Steam being conveyed hot, thro' its Neck, to the Ear of the Patient, *Urina capri vel tauri aut fullonia vetus calefacta, vapore per lagenæ collum subeunte.* Whence 'tis plain, this Vessel had a Neck, and a large Belly, possibly not unlike our Glass Bottles, only its Belly was more nearly of a spherical Figure, which rendered it more proper for this Purpose of refracting the Rays into a common Focus. That the Ancients had the Use of Glass, is undoubted; a Vessel therefore, made of Glass, of a spherical Figure, such as are now commonly sold at the Glass-Shops, under the Name of Jewellers Glasses, performs this whole Matter, of setting the dry combustible Fuel on Fire, by the Sun's Rays. Some such Vessels are represented in the ancient Bas-relieves of Compotations or Banquets.

So that this Passage out of *Panvin* might be added as a farther Proof of what this ingenious Gentleman says, of the Ancients knowing the Use of Burning-Glasses.

HERE I shall observe, that the Ancients made Looking-Glasses, *Specula*, not only of Metal, but of Glass: *Pliny*, *Lib. 36. cap. 26.* having before treated of the Art of Glass-making, adds, *Authores sunt, in India e crystallo fracta fieri, & ob id nullum comparari Indico. Levibus autem aridisque lignis coquitur, addito Cyprio, ac Nitro, maxime Ophirio. Continuis fornacibus, ut æs, liquatur: massæque fiunt colore pingui nigricantes, &c. Ex massis rursus funditur in officinis, tingiturque: & aliud flatu figuratur, aliud torno teritur, aliud argenti modo celatur, Sidone quondam iis officinis nobili: siquidem etiam SPECULA excogitaverint.* From which

which Passage it may be gathered, that the *Sidonians* made reflecting Looking-Glasses of this black semiopaque Glass, and that they knew the Way of grinding Glasses also; as seems to be plainly hinted, by *Torno teritur*. The Glass was ground, or work'd off, by a Turner's Engine, or by turning it into the Figure desired: This, without any Foil, being made of black, or semiopaque Glass, will make a Sort of Burning-Glass, tho' not so good as those foiled on the Back with Quicksilver.

BUT to come to the Passage cited by this Gentleman, concerning Burning-Glasses, out of *Pliny*, *Lib. 36. cap. 26.* the Words are these: *Est autem caloris impatiens (scilt. vitrum) ni præcedat frigidus liquor: cum addita aqua vitreæ pilæ sole adverso, in tantum excandescant, ut vestes exurant.* Whence, by the Way, 'tis apparent that the Ancients did not know the true Reason why the Balls of Glass, filled with Water, which they made Use of, set on Fire the combustible Matter placed in its Focus, since they supposed that the Glass itself was considerably heated; whereas it is no more heated for this Transmission of the Rays, than if it were of a Plane, or any other Figure.

THE next Place, quoted out of *Pliny*, *Lib. 37. cap. 2.* by this Gentleman, is this; *Invenio Medicos, quæ sunt urenda corporum, non aliter utilius id fieri putare, quam Crystallina pila adversis posita solis radiis.* This Use of Crystal Globes, for Cauterizing, is also mentioned by *Matthiolus Dioscorides*. *Diosc. Lib. 5. cap. 116.*

BUT altho' it is evident, from all these Passages, that the Ancients knew that the Rays of the Sun, transmitted either thro' a Sphere of Crystal, or a round Ball of Glass filled with Water, would set any combustible Matter on Fire, at a short Distance, *viz.*

Yet, I presume, this can be no Proof of their ever knowing

the Way of making either plano-convex, or double convex Glas-Lenses, such as are now made, either by their turning or grinding them of two spherical Segments, or by fastening two Portions of spherical-blown Glas Globes, and then filling the Space between them with Water.

So that I am of Opinion that their Knowledge did not reach to the Contrivance of Lenses, as now made; therefore their Burning-Glasses might rather be termed Burning-Spheres, since they were wholly ignorant of the true Cause of Vision, and of the Union of the Rays, by Refraction, into one Focus. Much less were they capable of contriving either Microscopes or Telescopes.

THERE is indeed a Passage quoted by *Petrus Borellus*, out of *Porta*, in his Treatise of Natural Magick, (*De vero Telesc. Invent. cap. 1. Porta Lib. 17. cap. 5.*) concerning *Ptolomæus*, that he could discern Ships approaching, to the Distance of 600 Miles; (*sexcenta millia*) but, as *Borelli* observes, this Contrivance, if true, remains *inter arcana*; and indeed the Convexity of the Earth contradicts such a Distance; for allowing, the most that can be, to the Refraction by the Air, the greatest Distance a Ship can be seen at, by Telescopes, now amounts but to ; so that *Ptolomæus*, in all Probability, had his Intelligence by the Means of *Specula*, or *Watch Towers*, placed at several intermediate Distances, which, by some Signs, gave Notice to each other, of the Ships and their Number. From all which, and much more that might be alledged, I think it is evident, that Burning-Glasses, of two spherical Segments, were not known to the Ancients. But it is not my Design to enquire into the first Inventor of Telescopes, in this Place, or whether *Roger Bacon*, as it is very probable, knew the perfect Reason of Vision, and the Construction of Telescopes,
long

long before either *Metius*, *Galileo*, or *Drebell*, or rather *Joannes Lippersein* of *Middelburgh* in *Zealand*, as *Borelli* (*Cap. II.*) shews in the forementioned Treatise, about the Year 1609; or his Father, *Zacharias Joannides*, about the Year 1590; but of this enough.

UPON the Whole, I am of Opinion, that the Ancients were wholly ignorant of refracting Burning-Glasses, except Spheres, and therefore agree with this Gentleman, that it is no strange thing that they had neither Telescopes nor Microscopes; both which noble Inventions have discovered new Worlds to the last and present Age.

BUT these Remarks I submit to the more learned Judgment, and Censure, of this illustrious Society.

Mr. WALLER's Account of a Book, intituled, Trattato dell' Apoplessia, &c. Dal Dottor Domenico Mistichelli da Fermo. In Roma 1709.

THIS Treatise is divided into two Books, and each Book into three Sections, which are subdivided into Chapters.

IN a short Preface to the Reader, the Author informs him, that the unusual Number of Persons, who died suddenly at *Rome*, in the Years 1705 and 1706, was the first Motive to his writing this Discourse; to which, a second was his Desire of making known a new Remedy, which his Experience had confirmed very advantageous in this Distemper; to which Publication also, the Sollicitation of his Friends concurred.

THE first Book treats of *Matters relating to the Theory of this Distemper*: In which the first Section gives an Account of the Body anatomically considered, with Respect, more particularly, to *Apoplexies*.

THE five first Chapters treat of the Head, with its Coverings, and Contents, the *Brain, Cerebellum, and Origin of the Nerves*; in which there is little Difference from other Anatomical Treatises of the like Nature. I shall take Notice of some: He observes, that the *Dura Mater* is furnish'd with very numerous Branches of the Blood-Vessels of the *Carotids* and *Jugulars*; that tho' it seems to be a simple Membrane, yet it may rather be called a *Tendinous Muscle, sui generis*; since, as he says, it has the Force, and performs the Office of a Muscle. It has a Motion of Depression, and Elevation, from the Pulse in the Arteries, which drives the volatile Spirits of the Blood into the small Pipes of the Brain, and those Parts which are the immediate Roots of the Nerves; which volatile Essence, conveyed farther on, and being mix'd with the Blood, are called the *Animal Spirits*, and irradiate the sensitive and motive Parts of the Body.

IN the 6th Chapter, of the *Medulla Oblongata*, he sets down some Particularities observed by himself. The *Medulla Oblongata*, he says, is a Continuation of the callous Substance of the *Brain* and *Cerebellum*, derived from four Heads, which join into one Stalk, of a conical Figure, about three Inches long: This, stripp'd of its Membrane, differs not from the Substance of the Brain. On the lower Part, it has a strait Furrow running up the Middle, on the Outside; it has that cineritious Substance on the Inside, which makes the cortical Part of the Brain. He says, he could never find, in Brutes, or Men, dying of a violent Death, any
tubulous,

tubulous, fistular, or fibrous Parts ; but, rather, a soft, mucous, tomentose Body : That he had observed it raw, boiled, and infused, for several Days, in Brandy, Vinegar, and Oil, and always found the same Consistence, only a little dark, or livid, Alteration of the Colour of the outward Part : That being cut transverse, and gently pressed on the Outside, a tomentose, medullary Substance, ouzed out in little Grains, as it were, from so many *Tubuli* ; whence he suspected, that the Fibres, as well those of the *Pia Mater*, which penetrate the Windings, as those of the Membranes, which cover the Ventricles, insinuate into the Substance of the Brain ; and, being prolonged to the *Medulla oblongata*, and *spinal*, form so many *Tubuli* to contain the forementioned tomentose Substance. Again, what is very particular, is the Fibres of the Membranes which encompass the *Medulla* round : Having kept it covered, with its Membranes, 8 or 10 Days in Vinegar, in which they were thicken'd to about the Breadth of the Back of a Knife, he diligently separated the Blood-Vessels, which form a Kind of a Net-work ; and, then, taking off the external Fibres, and coming to the last Covering, he observed, that the Stalk look'd like a braided Tress of Hair. Many small Bundles, or Collections, of strait Fibres, are brought over many transverse ; and many oblique, again, wove over the transverse, and strait ones ; so that, following one Collection of Fibres, you will find it sometimes uppermost, and sometimes undermost in the Brede, till they pass out on the Sides, to form the spinal Nerves on each Side. This, he says, is more observable on that Part, or *Caudex*, of the *Medulla*, which is inwards, or the Fore-Part, than on the Back-Part, next to the *Nucha*, where only some oblique Fibres run over the strait and transverse ones, which seem to come from the Center, to make up,

with

with the others, the spinal Nerves. *2dly*, This Texture is only observable in the superficial Part, not wholly stripp'd of its membranous Coat; therefore in that membranous Coat itself: For, when that is quite taken off, there remains only the simple, tomentose, Substance of the Brain; in which, with Signior *Campani's* Microscopes, he could discover nothing observable. *3dly*, These Fibres which thus concur in Bundles, to form the spinal, lateral, Nerves, at the Place where they pass thro' the Holes of the *Vertebræ*, are bound round, as it were, with a small Ring. *4thly*, He says, this Observation of the Texture may rather be applied to the membranous Fibres which encompass the *Medulla*, than to the *Medulla* itself, as is done by Dr. *Willis*, in his *Anatome Cerebri*.

THE 7th Chapter treats of the Nerves proceeding from the *Medulla oblongata*, and spinal Marrow. In the Enumeration of these, he follows the Order of Dr. *Willis*, reckoning up 10 Pair of Nerves proceeding from the *Medulla oblongata*: Those of the spinal Marrow he distributes according to the Parts they proceed from.

IN the 8th and 9th Chapters he speaks of the Use of the Brain. Here he disagrees from *Willis* and *Malpighi*, that it is a great Gland, for several Reasons; and that it cannot be the Place for the Generation of the animal Spirits: Which he confirms by an Observation of a Child born without a Brain, only it had the *Meninges* filled with a ferous Liquor. He says then, that the *Meninges* are an Expansion of the Tunicles of the *Carotide* Arteries of the Neck, and jugular Veins; that this Membrane encompasses the whole Brain, the spinal Marrow, and the Nerves: Whence, says he, it may, without Difficulty, be apprehended, that the Spirits, or volatile Essence, of the Blood, carried thro' these Vessels of the *Meninges*, and, by
reason

reason of their Subtility, brought into the fibrous Interstices of these continued Membranes, (which Membranes also encompass every Fibre of the Muscles in the Body and the Spirits) are, by the Motion of the said Membranes, forced forwards to all the sensitive and moving Parts of the Body. In fine, our Author maintains, that the animal Spirits are the more subtile Parts of the Blood separated from the capillary *Carotide* Arteries in the *Pia Mater*, chiefly by means of the Interstices of the Fibres, of which the Membrane consists; that also along the spinal Marrow, which is but a Continuation of the same Membrane, the same Separations are made; and, that to have a greater Plenty of Spirits in Readiness for Use, for all the animal and voluntary Functions; and that the chief Use of the Mass of the Brain is, by its Softness, Coldness, and Bulk, to distend, and bear up the *Meninges*, and help it in the Separation of this subtile Spirit from the Blood; which he endeavours to confirm by several Reasons and Observations.

THE 10th and 11th Chapters shew, *how Sensation and animal Motion is performed*. As to the first, he says, three things are to be considered; the *Objects*, or sensible Bodies, the *Organs*, and the *Soul*: The *Objects*, by their Materiality, or extended Quantity, must either immediately touch the Sensory, or mediately impress upon it their Motions, which the Schools call *Species*: Whence all Sensation may be reduced to Touching. This he exemplifies in the Hearing, Seeing, and the rest of the Senses. As for the *Organs*, tho' *Donato Rosetti* makes them 11, yet he is contented with five; to all of which the Nerves arising from the *Medulla oblongata*, conveying the animal Spirits, are continued. That these animal Spirits are corporeal, is evident from a certain Modification which happens either in the soft, nervous, Fila-

Filaments, or in the animal Liquids contained in them, which they communicate *partem post partem* to the *Meninges*, from whence the animal Spirits are derived in the greatest Plenty. The *Anima*, or *Soul*, being immaterial, is not subject to Modifications, or of receiving Impressions from the Spirits or Nerves, which are material. But as *Hippocrates* says, *Qualiacunque patitur corpus, talia videt anima*, which has a Power of comprehending these Impressions, and distends its Powers, and raises the Passions, which it does, or ought to regulate with its Approbation, or Disapprobation. That indeed, without this *Soul*, the Impressions would be made, but they would neither be discern'd, nor any Use made of them.

As to the next Thing, how animal Motions are performed, he says, The Muscles are a Collection of fleshy Fibres; that it is to be observ'd, they are all envelop'd with a Membrane dense, strong and nervous; in which external Membrane all the Nerves terminate with their numerous Ramifications, that it is impossible to separate this Membrane from the contained fleshy Fibres, without breaking innumerable Filaments of the Nerves; so that the animal Spirits pass by these Filaments into all the fleshy Fibres that make up the Belly of the Muscle. By Means of which, the animal Spirits, which are fluid Bodies, enter into, swell, and so contract the Muscle, by drawing the tendinous Parts, that are at each End, nearer together: This he illustrates by a Cable, which, being wetted, is thereby shortened. That when, according to the Empire of the Soul, there is ordered more of these Spirits to one Part, than to another, of the *Dura* and *Pia Mater*, either within the Scull, or along the Canal of the spinal Marrow; then the corresponding Branches of it, on that Side, are acted upon, and the corresponding
Muscle

Muscle shortened, and the Member moved accordingly; that this is done independently on the Will, sometimes, and these are called involuntary, or natural, Motions.

A N *Apoplexy* often happening from a Defect in the Heart, in the 12th, and four following Chapters, he considers the *Thorax*, *Pericardium*, and the *Heart*, with its Auricles and Ventricles, its Substance, Use and Motion; in all which, there is nothing different from other Anatomists; only as to the Heart he agrees with Sig. *Giacomo Sircibaldi*, in his *Apollo Bifrons*, that the Substance about the Heart, commonly taken for Fat, is made of the serous *Lympha* contained in the *Pericardium*, brought to that Consistency by the Heat of the Heart, like a Sort of Glue, hardened, and sticking close to the Heart, since it is not melted by Heat, like Fat, and crackles in the Flame of a Candle. As to the Motion of the Heart, he says, indeed, that its *Systole* is caused by the Spirits, conveyed by the Branches of the *par Vagum* to the Membrane that covers it; *but it were to be wished he had more particularly explain'd, how this Contraction is so regularly and alternately caused and continued.* He endeavours to explain it by the alternate Vibrations of the Balance of a Watch, which the circular Motion of the Balance Wheel continues backwards and forwards, by the different Position of the Pallets; so the circular, yet alternate, rushing in of the Blood and Spirits, cause the alternate Motions of the Heart and Pulse. As to the Observation of a Frog's, and some other Creatures Hearts beating, after they are taken out of the Body, he compares that to a Steel Spring, which, being bent one Way, will continue its Vibrations backwards and forwards for some Time, after the first bending Force is removed. *In this, I think, he is short.*

THE 17th and 18th Chapters of this Section, describe the Veins and Arteries, with their several Coats and Structures, together with the Nature, Motion, and Use of the Blood. As to which, he says, many Principles of it are discovered, *viz.* Certain subtile, airy, volatile Particles, discernible by the Plenty of Vapours that arise from it, while it remains hot, when fresh taken out of the Body. *2dly*, Salts of divers Figures, observed in the *Serum*, by the Microscope. *3dly*, Several fibrous *Stamina*, or Fibres, observ'd in the thick, or grumous, Part, when wash'd in warm Water. *4thly*, Some small red Globules, made of little oval, plane Corpuscles, which, separated, are transparent, but, being joined, appear more or less of a purple Colour. *5thly*, Several Particles of Sulphur, which Chymistry procures out of the thick Part, of a yellow, or red Colour. *6thly*, Several little *Moleculæ*, derived from the various Combinations of the fore-named Principles. *7thly*, A great Proportion of a watery Fluid, serving as a Vehicle to the rest. *8thly*, a great Quantity of Chyle, not yet converted into Blood. To this Fluid, or Blood, he gives a threefold Motion; an Agitative, from the different specifick Gravities of the Contents; a Fermentative, and a Circular, from the Action or Pulse of the Heart: All which Motions he applies to the Increase, Nutrition, and Preservation of the Individual.

THE second Section relates to the Theory of an Apoplexy, and is divided into 14 Chapters. I shall only take Notice of what I think most observable. He says, that the Apoplexy, as was remarkable in that at *Rome*, so frequent from the Autumn of 1705, throughout the whole Winter, and Spring following, being a sudden Deprivation of Sense and Motion, it must be granted, that the Parts affected, are either the animal Spirits, or
 .the

the Nerves, or both; and since this Stroke is so instantaneous through the whole Body, 'tis reasonable to believe that the Mischief is impress'd on the Principle of all the Nerves that is on the *Meninges*, tho', since there is a continual Circulation, he allows that the Part immediatly affected, in an Apoplectick Fit, may be in the *Thorax*, the Heart itself failing to send a requisite Quantity of Blood to the Brain.

HAVING thus mention'd the Parts affected, he proceeds to consider the Signs of it. These Signs he distinguishes into, Those which shew Persons subject to it; An impendent Evil, or Fit; A real present Fit; and, Those which distinguish this from other Ailments: For which I must refer to the Author; taking Notice only of some Remarks: As, that sometimes in an Apoplectick Fit, the Pulse is full and strong, and without any Fever; and this accompanied with a Snorting in Breathing, and a Relaxation of the Sphincters of the *Anus* and *Urethra*. In the next Place, amongst external, or remote Causes, he reckons Evacuations either suddenly stopp'd, or unusually large, of what Kind soever.

IN the 5th Chapter of internal Causes, he enumerates several, some relating to the Brain itself, and others to the Heart.

IN the next Chapter, he mentions Apoplexies caused by a Blow on the Head, or Stomach; the first causing an Extravasation of Blood in the capillary Vessels: And here he gives some Instances of sudden Death from a Blow on the Head, especially near the Temples, with the Reason of such sudden Deaths; such as the Loosening the Contact of the Brain from the *Meninges*, Extravasation of the contained Fluids, &c. which must necessarily interrupt the Course of the Spirits.

As to Blows on the Pit of the Stomach proving mortal, he cites a Case in *Hippocrates*, of a Boy

kick'd by a Mule, and agrees with *Willis*, that the outward Coat of the Ventricle, being all nervous, and the Nerves of the *Par Vagum*, brought thither, form, near its Orifice, remarkable *Plexus's*; whence it has a wonderful Communication with the Brain and Heart, and so Convulsions, Syncope's, and the like mortal Syptoms, happen upon a Hurt there.

THE 7th and 8th Chapters, treating of Apoplexies from Hurts on the *Pericranium*, and Fractures of the Skull, have little remarkable, more than is generally known.

IN the 9th Chapter, he observes, that Hurts on one Side of the Head cause a paralytic Affection on the contrary Side. As to this, having observed, that *Hippocrates* has taken Notice of this Case, he explains it by what he had before related of the Nerves, in the *Meninges of the Medulla oblongata*, that they are interwoven and braided, so as those which proceed, at first, from the Left Side Fibres of the *Meninges*, have their Branching-out to the Limbs, or other Parts, on the Right Side. He says farther, That the little Rings, which bind round the Nerves, at their Parting from the *Vertebræ*, may be convulsed, and so, stopping the Nerves, cause a Palsy.

THE remaining Chapters of this Section treat of the internal Causes of Apoplexies, the Vitioufness of the solid Parts, *viz.* Nerves, Membranes, Tunicles, musculous or tendinous Fibres, and the like, which, he says, proceed, either from their too strong Tension, or from their too great Flaccidity, or Feebleness.

THE first of these may cause a Strangulation, or Stoppage, of the *Canaliculi*, of the Nerves, and instantaneously stop the Heart. This he farther explains in the *Meninges*, and in the *Lymphatics*, within the Head.

ON the contrary, too great a Relaxation is as mischievous, from the Parts in that Case failing to send a sufficient Supply of Spirits, to the several Organs of the Body. And, as this Palsy is frequent in the outward Part of the Body, so it may, and does sometimes, seize the Heart, or *Meninges*. This Weakness of the Parts sometimes happens to the Arteries, which he makes the Cause of Aneurisms, the Varices, &c. This Case, generally, is preceded by very long Indispositions, or lingering Distempers.

THE 12th Chapter is concerning *Apoplexies* caused by the Density of the fluid Parts, the Chyle, Blood, Lympha, and *Succus Nervosus*, of all which he treats briefly.

AND, as all these Fluids are, sometimes, too thick, so, on the contrary, they are also, at other Times, too fluid, which is the Subject of his next Chapter. This, he says, he has frequently observed in the Cavities of the Body, especially in the Heads of dead Persons, they being filled with a bloody *Serum*.

THE last Chapter is of *Apoplexies* from *Narcotic Steams*. Speaking here of *Opium*, (which by the Way he seems not to have a good Account of) he makes the sulphureous and viscous Quality of it to bind, and, as it were, glue up, and so stop the Passages of the Spirits: Whence Sleep, and, if taken too largely, Death follows. He makes the Suffocation by Charcoal, to be from the same Cause, in which he is, without doubt, mistaken, their Effects, and Manner of acting on the Body being quite different.

HERE he observes, that the Wines of *Rome*, when mix'd with Water, will not deplete, unless helped with Flower of Brimstone, which their Vintners call *Ciambella* (a *Simnel*;) but if they put too much into it, as they are apt to do in re-

fining either too gross, or thick, Wines, the Narcotic Sulphur, thereby mix'd with the Wine, proves very mischievous.

The Third SECTION.

Of the particular Causes producing the frequent Apoplexies at Rome in 1705-6.

IN order to explain this more satisfactorily, our Author premises several *Lemmata*.

Lemma I. OF Respiration and its Necessity.

THE Blood-Vessels in the Lungs, being destitute of the fleshy Fibres that accompany all the Arteries of the rest of the Body, are supplied, in this Respect, by the Spring of the Air admitted into the *Vesiculæ* of the Lungs, on which the capillary Blood-Vessels are ramified; which not only helps forward its Motion, but carries off, when expired, the noxious Humours from the Blood. Here he mentions several other Uses of Respiration: And, in

THE 2d *Lemma*, treats of the principal Use of Respiration, *The Introduction of an aerial Nitre into the Blood.*

Here he mentions this Experiment: If you omit to tie up, very close, the pulmonary Vein, and Artery, and blow up, by the Windpipe, the Lungs of any Animal, and then tie up the *Aspera Arteria*; yet the Air will find a Way out, and the Lungs sink: Which, on the contrary, will not happen, if the Extremities of the pulmonary Vein, and Artery, are well tied up: Whence he argues a Communication of the Air with the Blood. He also observes the Difference of Colour in the Blood, before, and after, its passing thro' the Lungs: Observing farther, that our Atmosphere is impregnated with this nitrous Spirit; he adds, that if some few Drops of the Chymical Spirit of Nitre be dropp'd on black, cold, and coagulated, grumous, Blood,

Blood, it will not only render it fluid, but florid, and like arterial Blood.

To this he subjoins, that Nitre, having an expulsive and elastic Power, communicates to the Blood, by Means of Respiration, that which causes its Fermentation, and continued internal Motion; citing *Galen (Lib. de Resp.) Aer non ad refrigerandam, sed ad nutriendam vitalem flammam, animalibus inest.*

THE 3d *Lemma* is to shew, that this nitrous aerial Spirit, mix'd with some other Principles in the Blood, compounds, in the Veins and Arteries, a Substance very like the Air which encompasses us.

As to this Point, having observed that our Atmosphere is a Compound of all Sorts of Particles exhaled from Earths, Minerals, Vegetables, Animals, &c. he says, that what pure Part soever may be received into the Blood, yet, in that Blood, it meets with the like Particles conveyed in the Chyle, from the several Foods eaten; whereby, when mix'd therewith, it becomes like the encompassing Air.

BESIDES, finding those Persons, that dwell in marshy Places, subject to ill Habits of Body, he argues, that the Air of such unhealthy Places, some Way or other, gets into the Blood, and that, by the Breath, seems the most likely.

THE 4th *Lemma* is, that the Air, mix'd with the Blood, agrees with, and participates of the Condensation and Rarefaction of the Ambient.

HAVING mention'd the several States of the Air, in respect to Condensation and Rarefaction, and compared its component elastic Particles, to incurvated Steel Springs, always endeavouring to dilate themselves; and observed, that it is the Particles of Air, in Spirit of Wine, in Thermometers, which dilate, or contract, by Heat and Cold: He

urges, that, for the same Reason, the Air, contained and intermixed with the several Fluids of the Body, must also participate with the Alterations of the Ambient.

HAVING premised these *Lemma's*, in the fifth Chapter, he treats of *Apoplexies* caused by the Rarity, or Density of the Air, external and internal.

THIS Alteration of the Temperament of the Air, when to Excess, hinders that due Separation of the Humours, and more spiritous and useful Parts from the Chyle and Blood, in the Harmony of which, Health and Strength consists: Too great a Condensation, clogging, and thereby hindring this due Separation; and the Contrary, forcing off unfit Particles, especially to the Brain and Meninges, where the Separation of the animal Spirits is made.

FROM these *Lemmata*, our Author, as so many Corollaries, deduces the Causes of Faintings, or a Sort of *Apoplexies*, in the too excessive Heats of the Summer, from a too great Rarefaction. As on the Contrary, the Fixation of the Fluids, by excessive condensing Cold. The falling of Fruits from the Trees, at both these Extreams, &c. confirming it.

THE 6th Chapter, being his 5th *Lemma*, is to shew that the *animal Spirits* are compounded of a two-fold volatile Essence, viz. a sulphureous from the Blood, and a nitrous from the Air.

SINCE, it must be granted, there is in the Blood a continual Motion and Fermentation of the several different compounding Principles, it may easily be allow'd, that there is separated in the Brain a more fine and subtile Essence, which, communicated to the Nerves, is what may be called the animal Spirits, the animal Liquid, or *Sucus Nervosus*.

HE says, as from Wine fermented, an ardent sulphureous Spirit is extracted ; so Blood, after its frequent Motions and Fermentations, affords the like sulphureous Spirit to the Brain or Nerves, mix'd with the nitrous Spirit taken out of the Air.

THE 7th Chapter of *Apoplexies*, from the Condensation of the nitrous Spirit, relates this Experiment.

IF, near an unstopp'd Bottle of fresh-drawn Spirit of Nitre, another open Bottle of Spirit of Urine, or Sal Armoniac, be placed, the Steams from the Nitre will be thereby condensed, like a white Smoak, which, instead of evaporating into the Air, falls down on the Table, or Place, where the Bottles stand. Whence he argues, that whenever an urinous Spirit abounds in the Blood, it produces the same Effect in the nitrous of the animal Spirits, and so causes an *Apoplexy*.

The 8th Chapter of *Apoplexies*, from the Condensation of the sulphureous Part of the animal Spirits.

THIS he explains by rectified Spirit of Wine, coagulating with a small Quantity of the urinous, or Sal Armoniac, Spirit ; and whereas he had before asserted Wine and Blood to consist nearly of the same Principles, he hence deduces another Cause of *Apoplexies*.

As to the Objection, that Spirit of Sal Armoniac, Hartshorn, and the like, is given, with Success, in Apoplectic Fits ; he says, if such Spirits were immediatly mixed with the animal Juice, the Mischief would soon appear ; but after passing thro' so many Alterations, as they suffer in the *Viscera*, they do neither Good nor Hurt ; and if in a Fit, as it is possible, they do any Good, it is by their violent irritating the Nerves of the Palate and Tongue, and likewise those of the Stomach,

which, as one Nail drives out another, so it may shake, and open the present Obstruction.

THE 9th Chapter, being the 6th *Lemma*, shews how, from these Principles, new, or second, Principles may be generated in the Blood, and other Humours, which may prove morbid and mischievous.

WHETHER the Blood be composed of Galenic, Chymic, or Democratic Principles, yet it must be granted, that it may, and does receive such Alterations, both in its more fluid and solid Parts, as to cause great Disorders in the Body. Thus, by the Circulation, some Parts are brought together and stopp'd, where they ought not to be; and, by Fermentation, some are raised up, and rendered conspicuous, in Places where they should not.

THIS he exemplifies in Wine, which, according to its Fermentations, receives great Alteration from the Winds, Storms, Thunders, &c. so as to become turbid, and quite alter'd in the Texture of its compounding Parts. So tho' the Blood has not, in it, any visible, fix'd, or tartareous Salts, yet such are often brought together in strumous and schirrous Affections; which, tho' invisible in the Blood, yet are, by the Mechanism of the Body, united and stopp'd, in the Glands most commonly.

THE same may be said of the Bile, the pancreatic Juice, and other Humours; all which, when vitiated, prove noxious to the Body.

THE 10th Chapter of *Apoplexies*, arising from morbid Principles produced within the Body, and there condensed in the solid and fluid Parts.

OUR Author begins this Chapter, with the Experiment of calcined Tartar condensing the Air in damp Places; whence its Oil, improperly so called, *per deliquium*: Alcalizate-Nitre, the white Magnesia, I suppose he means the Pyrites, do the same, &c. The same may happen in the Humours of the
Body,

Body, by condensing the more aerial Parts of the Blood into Water, or fixing, into a Sort of Salt, the nitrous Spirit. The alcalizate, acrid, fix'd Particles, he believes, to be what *Hippocrates* called the *Atra Bilis*.

HE remarks also, that as Spirit of Nitre, fix'd by Oil of Tartar into a nitrous Salt, dissolves, in warm Water, or damp Air; so the volatile Essence of the animal Spirits, either fix'd into, or condens'd into a Kind of Salt, by some Alchaly either produced, or introduced into the Blood, and easily after dissolved by the warm *Serum*, breaks the fibrous Texture, and thereby dispirits the Blood; so that it no longer furnishes that ætherial Spirit to the *Genus Nervosum*, which is the Original of all Motion and Sensation.

IN the next Chapter he applies what he has before mention'd, to the Case of *Apoplexies*. These Condensations, &c. either sometimes proceeding slowly, in chronical Distempers, or sometimes very quick; and, as it were, in a Moment, the forementioned Alchaly being communicated from one Part of continued Vessels, to another; so that quickly, the Whole becomes broken, disordered, and spoil'd.

THIS he endeavours to explain, by these Sort of Dews on Shrubs, and the Grass in Autumn, which look like the finest Spider's Webs; but, upon the least Touch of the Finger, on their Center, they fly away into a single Drop of Dew: So, by a small Touch, as it were, of this noxious Matter, the whole Order and Texture of the animal Spirits become broken, from Head to Foot; and from fine, rare, and delicate; become a thick, gross, and unactive Juice, and the whole animal Machine stopp'd in a Moment.

HE adds, that it is not always necessary that a lixivial Alchaly should destroy this volatile Essence; since without any Error, or external Cause, *Apoplexies* may happen, since, as *Galen* says, *Eti- am in sanguine potest generari venenum*: But this usually happens, when the Constitution of the Air contributes to such Distempers.

THE 12th Chapter contains his Conjectures, as to the Causes of the frequent *Apoplexies* at Rome, in 1705, and the Beginning of 1706.

OUR Author says, that he makes no Doubt, but that in the many sudden Deaths happening at Rome, in the fore-mention'd Time, several might proceed from the Causes set down, in the several Chapters of the second Section; so that all of them cannot properly be called *Apoplexies*: Yet they being so unusually frequent, he judges what he has laid down, in the present Section, had a great Share in producing this Evil.

HE proposes therefore to consider of three Matters, in so many Chapters.

The Thirteenth CHAPTER.

Why the forementioned Causes were capable of producing Apoplexies at Rome, more than in other Places.

HERE he takes Notice of the Situation of Rome, in the 42d Degree of Latitude, in a large low Plane, divided by the *Tiber*, where the Air being little moved by the Winds, and impregnated with mineral Exhalations, but chiefly with putrid Impurities from the neighbouring stagnant Waters, cannot but be prejudicial to the Health of the Body.

THIS Air, being overcharged with Impurities, becomes thick, so, as at a Distance, to look like a hovering Cloud; wherefore, being so dense, it must press down, or load, more than it should, its
elastic

elastic Principle; so that from the 4th and 5th Chapters, it may cause such *Apoplexies* as proceed from a thick Air.

BESIDES, *Rome* lying exposed to the South Winds, is too often mischievously affected by them. Since it is known, by common Observation, that when these Winds prevail, there is a sensible Languishing of the Strength and Spirits; which our Author attributes to the rarifying Heat of the Air, and, by its Dampness, a Dissolution of the Salts; so that there being conveyed to the Nerves an oppressive Quantity of Humidity, it renders them unactive.

THE Tramontane, or North Winds, are also, at some Times, very violent at *Rome*, and in its District, especially in the Winter; these, coming often unexpectedly, alter, of a sudden, the ambient Air, which, communicated to the Air within the Body, renders the Vessels unable to carry the spiritous Essence up to the Brain and Meninges; whence Apoplectic Affections may arise.

Lastly, The mineral Impurities from Vitriol, Alum, and Sulphur, which abound in the District of *Rome*, either taken in with the Air, or Nutrient, vegetable and animal, insinuating into the Humours, may either produce in them an urinous or lixivial, alkalizate Essence, either of which may condense the volatile Essence of the animal Spirits. Whence the Inhabitants of *Rome* are more subject to these sudden Deaths, than those of other Countries.

The Fourteenth CHAPTER.

Whence Rome was, at that Time, more than usually subject to Apoplexies.

IN the Summer and Autumn of 1705, the moist hot South Winds blew almost continually, at which Time *Apoplexies* began to be frequent.

IN the following Spring a very cold Season succeeded, with strong North Winds, with a considerable Frost; each of which stop, or retard, the Motions of the Spirits, which he confirms by two Aphorisms of *Hippocrates*.

THE Fruits of the Year 1705, were unripe, and the Wines poor, sour, and austere, which since, *Ex iisdem constamus, quibus nutrimur*, must lay the Seeds of future Mischiefs in the *Viscera*, especially in the *Serum*, and other Fluids in the Body. These Salts being, by a continued Fermentation, raised into an urinous Nature, and, by the wet South Winds, dissolv'd, and carried thro' the Body, even to the Head and Meninges; and afterwards, by the cold North Winds, fix'd, in the several Humours, might, by an Excess in either Case, cause a Failure, or Stoppage, of the animal Spirits.

HE believes also, that continual Fermentations may turn these immature Salts into a Kind of lixivial Salts.

HE observed old Men to be more subject to this Distemper, than young, as he supposes from this Reason: The young Men abounding more in a sulphureous Essence, which, when the North Winds bring the nitrous Particles, there being a sufficient Quantity of other, to mix therewith, increases the Spirits; whereas, for Want of that Sulphur in the old, the Blood, by the Nitre, is stagnated, and the few Spirits, they have, stopp'd.

The Fifteenth CHAPTER.

Wherefore since, in Rome, the Causes of this Distemper were universal, yet the Distemper was not so?

FOR the Causes of this Difference, he gives the different Ages, Sexes, Constitutions, Manner of Diet, and Way of Living: Whence, in some, there is such a just Balance and Proportion of Solids

lids and Fluids, of volatile and fix'd Parts, such a due Formation of the Glands, and other excretory Vessels, that there arises a due and regular Fermentation and Circulation of the Blood, and other Fluids in the Body ; all which contribute to Health. Whereas, when any of these are faulty, the Evil more readily seizes on the Patient; and especially, if they lay up the Seeds of it, by eating immature Fruits, or drinking sour, austere, Wines.

As a Corollary, he adds, that the ill Tempera-
ture and Disposition of the Air and Winds, in
those Years, was the occasional Cause ; and, as a
more remote Cause, he reckons up the unwhole-
some Food, and bad Wine, then generally taken.

The Sixteenth CHAPTER,

*Gives several Remarks on the malignant Fevers,
which, at Rome, frequently terminate in Apo-
plectic Symptoms.*

HERE he observes first, that every Summer
and Autumn, at Rome, and in the neighbouring
Campaign, there is an universal malignant Fever,
commonly call'd, Fevers from the Air. This In-
fection is very fatal to Strangers and Travellers,
nay, to the Inhabitants themselves, if they come
at that Time from a more healthy Place ; or, if
leaving the City, they go to other more healthy
Places, and stay there, or sleep there, and then
return Home.

THESE Fevers, he says, when it is little ex-
pected, end in a fatal *Apoplexy*.

To account for this, he says, that the Air of
different Climates has different Effects, and that it
requires some Time, before the internal Air in the
Body can be reduced to the Constitution of the
ambient ; which, while doing, causes Alterations
in the several Fermentations. Whence the Fer-
mentation

mentation, at that Time, is either too violent, or too remiss. Again, Sleeping, in a different Air from what we are used to, causes those Separations which are usually made in Sleep, to be differently performed from what they used to be.

THE Cause of these, happening chiefly in Summer and Autumn, is from the Heats then reigning, which cause too great a Rarefaction of the Humours and Fluids; whence they may more easily be altered by the noxious Exhalations; all which entering into the Body by the Breath, or Food, produce those disorderly Rarefactions, or Fixations, of the Animal Spirits before treated of; which happening either at the Beginning, or Declension of the Fever, may cause *Apoplectic* Symptoms.

THE last Chapter treats of several Phænomena accompanying *Apoplexies*.

AMONG these he reckons up, Failure of Motion, Sense, and Speech; Falling down; the Breathing hindered, or violent, and disorderly; a froathy Foaming at the Mouth; a full Pulse, vibrating, and sometimes natural; a Relaxation of the *Anus* and *Urethra*; the Intellect and Faculties of the Mind (which, without the Nerves, cannot act) failing, &c. all which he explains, and concludes his first Book.

The second Book is also divided into three Sections: The first of Chirurgical; the second of Medicinal Methods used in the Cure of this Distemper; and the third concerning the Diet: Of all which I shall be but short, having been already too prolix in the former Part.

THE first Chapter concerns Chirurgical Operations in general; and the three next of the Cure of Blows, or Wounds, on the Head, Fractures of
the

the Skull, and the like ; with the Prescriptions of several Ointments, Plaisters, Salves, &c.

IN the 5th Chapter he treats of Blood-letting in *Apoplexies*. This he recommends as beneficial, and, in many Cases, necessary, with the Lancet, in the Arm, or Jugulars, and sometimes has been practised in the Forehead ; but with due Respect to the Age of the Patient, and other Circumstances.

IN the 6th Chapter, treating of hot Irons, he mentions hot Pans held over the Head, Stupes in Brandy fired upon the shaved Crown of the Head, with other Cauteries applied to the Neck, Arms, Pit of the Stomach, and other Places. But above all, as the most efficacious Remedy, he advises the Application, to the Soles of the Feet, of an Iron heated, less, or more, according to the Exigence of the Patient ; of which Iron, and Manner of applying it, he gives a Figure ; affirming it the most certain Remedy, which rarely failed of Success. He produces several Authorities for this Practice : And,

IN the next Chapter, he shews the Method of Curing the Burn, after it has rouzed the *Apoplectic* Patient.

THE 8th Chapter concerns Vesicatories, Sinapismes, and lesser Cauteries, &c.

THE last of this Section mentions Frictions, Ligatures, and Cupping.

THE second Section relates to the Part of the Physician, in this Distemper, which he handles in 14 distinct Chapters, giving particular Directions and Recipe's, as the Case requires.

THE third Section respects the Diet, both of Persons cured, and subject to it ; with his Advice as to Preservatives ; in all which there is little extraordinary.

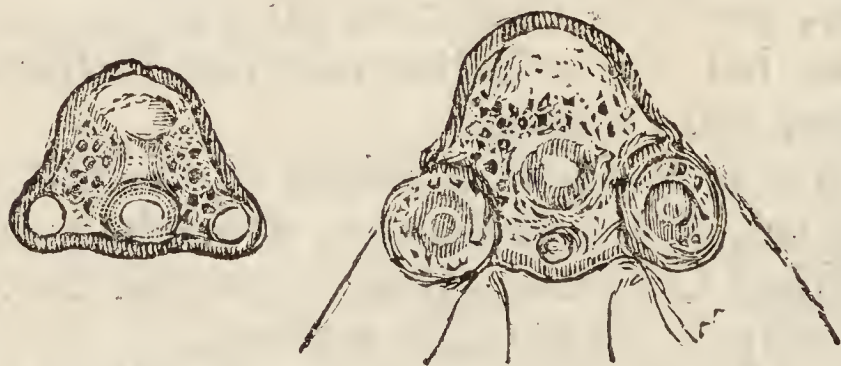
THE Author concludes his whole Work with some remarkable Cases of Persons, chiefly in the Hospitals at *Rome*, either dying, with some Observations on their Dissections, or happily cured, and that, mostly, by the hot Iron applied to the Bottoms of their Feet.

IN the Dissections mentioned by our Author, I find, he opened only the Heads of the dead Persons; taking that Part to be, chiefly, if not only, affected in *Apoplexies*; which, possibly, may be true, as to Distempers properly so called: Tho', on the other Hand, sudden Deaths may proceed from an immediate Stop on the Heart; and, indeed, he observes some had a good and natural Pulse, when at the same Time they lay in an *Apoplectic* Fit.

IN all those who died of Hurts in the Head, he found extravasated Blood, or Matter, or both, on the *Dura Mater*, or between the two *Meninges*, with a copious *Serum*, sometimes in the Ventricles of the Brain.

IN those dying *Apoplectic*, after malignant Fevers, the Blood-Vessels of the *Meninges* were turgid, with a black Blood.

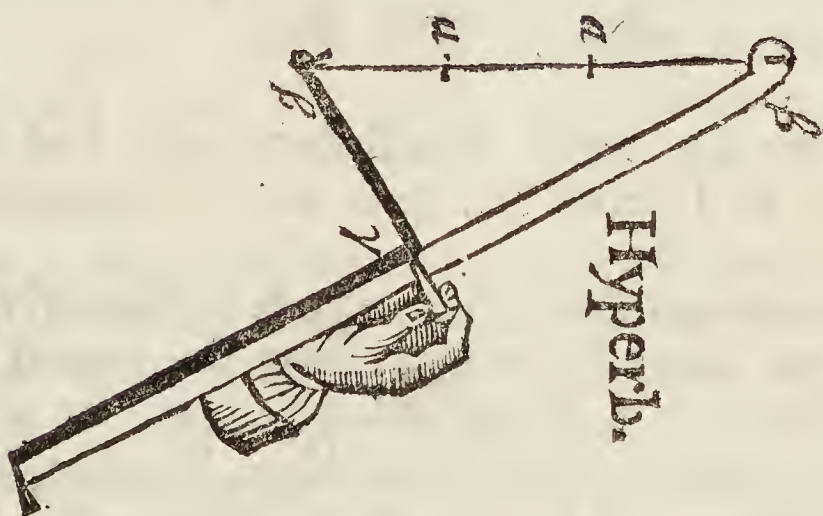
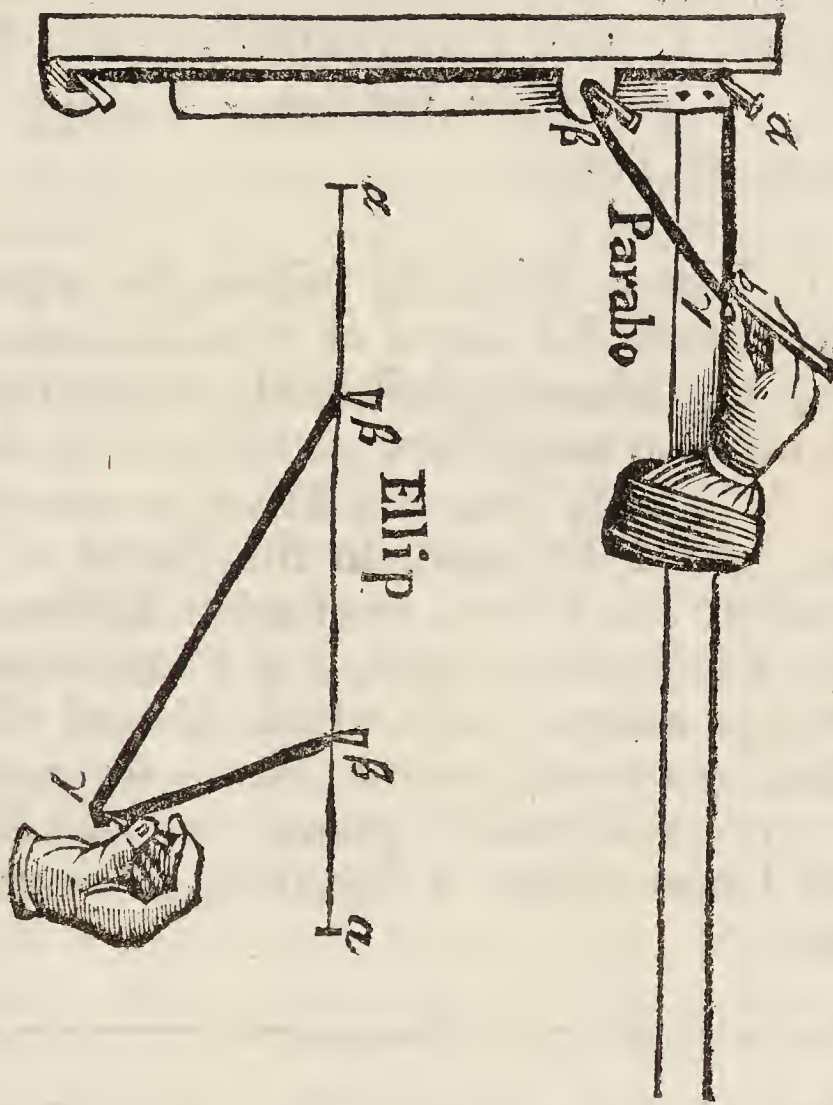
The Pores of the Sensitive Plant.



Altho' I do not find any verbal Account of the Sensitive Plant, that those Figures relate unto, yet I think fit to insert them, because they may probably be of Use to Persons that are minded to enquire into the Mechanism of that uncouth Vegetable.

W. DERHAM.

The Mechanical Way of Drawing Conical Figures.



$\alpha \alpha$ Vertices,
 $\beta \beta$ Foci,
 γ Punctum,

Sectionis.

C c

An

An Extract of a Letter to R. WALLER, Esq; from Dr. Cotton Mather, dated Decemb. 1, 1713, at Boston in New-England, of a Woolly Substance falling in a Shower of Snow.

TH O' I have unhappily mislaid the large and well-attested Account of what follows, yet, however, my Memory sufficiently serves me, to assert so much as may afford you a tolerable Satisfaction: Which is, That at a Town in one of our Colonies, called *Fairfield*, in the Depth of the Winter, there fell a *Snow*, as at other Times; but there was a large frozen Spot, (of I have now forgot just how many Acres) which, instead of the *Snow* that lay covered in other Places, was covered with a very considerable Quantity of that *Wool*, whereof I now tender a Specimen to your Acceptance.

Mr. WALLER's Relation of petrified Bodies of Men, &c.

November 12, 1713. *Mr. Baker, who had been Consul at Tripoli, &c. gave me this Relation.*

AB O U T 40 Days Journey, S. E. from *Tripoli*, and about seven Days from the nearest Sea-Coast, there is a Place called *Ougila*, in which there are found the Bodies of Men, Women, Children, Beasts, and Plants, all petrified, of a hard Stone like Marble: That about 1654, or 5, the *Cor-sairs* having taken several of the *English* Ships, Admiral *Blake* was sent with a Squadron of Men of War

War to *Tripoli* ; from which Place and *Tunis*, he had all the Captives delivered without Ransom ; at which Time, the Report of this Discovery of the above-mentioned was new, so that he obliged the Alkade to procure a whole Figure for him, which he promised. But *Blake* not staying long enough there, but sailing to *Legborne*, he sent a small Frigat to *Tripoli* to fetch it a-board ; in which Frigat one Mr. *Hebden* (then a young Gentleman) went, who told Mr. *Baker*, that he himself saw a Figure of a Man petrified, which was conveyed to *Legborne*, and thence to *England*, and that it was carried to Secretary *Thurlow*.

THE same Mr. *Baker* told me, That when he was at *Tripoli*, he spoke with several *Turks*, who affirmed themselves to have been Eye-Witnesses of the said Petrifications : That, particularly, an Officer that commanded a Garrison of 200 Men, on a Frontier Place, called *Derney*, not many Days Journey from the Place, had promised him to procure a Figure thence ; the same affirmed the Relation ; that, accordingly, he sent some Spies to find the Place, which, at that Time, they could not, as he sent him Word, it being wholly buried in the Sands, which in that Country are carried in great Clouds ; that a strong North Wind blows the Sands off, and by that Means discovers the Place ; which, at other Times, is covered by these Sands.

HE farther told me, That this Mr. *Hebden* died about two Years since, a Prisoner in the Fleet, tho' he had been formerly sent to *Moscow* by King *Charles II.* He said, he had procured the Arm of a *Fig-Tree*, as big as his Arm, petrified ; whereon the Bark and Wood were plainly visible ; the Bark grey, the Wood yellowish, of the true Colour of the Plant ; that in the Bark was a Grove, in which were several small Insects like the Lady-

Cow petrified; that he had presented this Piece of petrified Wood to my Lord *Torrington*, in whose Possession he believes it now is.

Dr. H O O K's Answer to some particular Claims of Mons. Cassini's, in his Original and Progress of Astronomy.

HAVING lately perused a Discourse of Mons. *Cassini*, concerning the Original and Progress of Astronomy, and of its Use in Geography, and Navigation, I could not chuse but take Notice of several Passages of it, which seem more particularly to concern this *Honourable Society*; and the rather, because I do not find that it hath been mentioned by any hitherto, but suffered to pass into the World for Authentick, and will be so concluded by the future learned World, if it be not otherwise informed of the Errors, or Mistakes, therein contained.

THE first is, concerning the Beginning, and Original, of the *Royal Society*: Concerning which he might have been much better informed, if he had taken Notice of what is said concerning it in *Dr. Sprat's* History thereof; but that, it seems, did not so well suit to his Design of making the *French* to be the first. He makes, then, Mr. *Oldenburg* to have been the Instrument, who inspired the *English* with a Desire to imitate the *French*, in having Philosophical Clubs or Meetings; and that this was the Occasion of founding the *Royal Society*, and making the *French* the first. I will not say, that Mr. *Oldenburg* did rather inspire the *French* to follow the *English*, or, at least, did help them, and hinder us. But 'tis well known who were the principal Men that began and promoted that

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Design, both in this City, and in *Oxford*; and that a long while before Mr. *Oldenburg* came into *England*. And not only these Philosophick Meetings, were before Mr. *Oldenburg* came from *Paris*; but the Society itself was begun, before he came hither; and those, who then knew Mr. *Oldenburg*, understood well enough, how little he himself knew of Philosophick Matters.

THE next Thing, I take Notice of, is his asserting the *Royal Academy*, at *Paris*, to be the Inventors of many Inventions, and Improvements, of Astronomical Helps, which were invented, and improved here, by some of this *Society*, before that at *Paris* was founded.

THE first Thing, he instances in, is the Pendulum Clock, which, he says, was invented by one of the Members of that *Academy*. I suppose he means *Monf. Chr. Huygens*, because he mentions the Regulation of them by the Cycloid: Now, 'tis well known, that this Person was a Member of the *Royal Society* four or five Years before the *Royal Academy* was founded, which was not till the Year 1666: The *Royal Society* has, therefore, more Right of Claim to that Improvement, than the *Royal Academy*; but, indeed, the Invention was precedent to both, and was made in *Holland*, and from thence sent into *England* about the Year 1659, or 1660.

THE next Thing, he lays Claim to, is the Regulation of Watches, by a Spring applied to the Balance; but that is somewhat more injurious than the former: For, it was not pretended to by *Monf. Zulichem*, till about the Year 1675; whereas it was here invented, before the Year 1660; in which Year, I, and three other Members of this *Society*, had a Grant of a Patent for the Use thereof; and some Years after, when *Monf. Zulichem*

came to be informed of it, he wrote a Letter against it as a Thing not practicable.

THE 3d Thing is about the finding a Standard for an universal Measure by the Length of a Pendulum vibrating a certain Time. This, I believe, was first invented, and tried, by Sir *Christopher Wren*, some Years before the Beginning of the *Society*.

BUT that this Length would not be the same, all over the World, was discovered by me to this *Society*, 32 or 33 Years since, as will appear by the Registers of this *Society*.

THE 4th Thing, he instances in, is the Improvement of Telescopes, both for Length and Goodness, which was first performed here by Sir *Paul Neile*, Sir *Christopher Wren*, and Dr. *Goddard*, who instructed and employed Mr. *Reives* in the manual Operation; and, by that Means, it was carried to the Perfection of making Object-Glasses of 60 and 70 Foot long, very good, before any Mention was made of such being made in *France*. Some such Attempts, indeed, had been made in *Italy*, by *Divini* and *Campani*: But upon comparing one of the best of them, brought hither by Mr. *Monconys*, I found, that a Telescope I had then by me, of Mr. *Reives*'s making, of the same Length with the *Italian*, was full as good, if not better; which Mr. *Monconys* acknowledged.

A 5th Thing, he instances in, was a Way of using these Object-Glasses without Tubes. This I practised here long before any Mention was made of its being known beyond Sea, where, I suppose, it was first used by Mr. *Huygens*, who hath printed a little Discourse concerning it; but that was above 40 Years after I had used it here in *England*.

A 6th Thing is the Application of Clock-Work, to keep the Glass directed to the Object; but who contrived this Application, will appear by my Animadversions on the *Machina Cœlestis* of *Hevelius*.

A 7th

A 7th Thing, he instances in, is the Application of Telescope Sights to Instruments, which was invented and perfected here long before any such were to be found, or heard of, in *France*. And Mr. *Bullialdus*, and several other of the *French* Astronomers, as well as *Hevelius* in *Dantzick*, and Dr. *Wallis* here, did disapprove of them, after I had published the Use and great Benefit of them, for Sights of Instruments, in my *Micrography*, in my Attempt to prove the Parallax of the Earth's Orbit, and in my *Animadversions*; and by the Letters published by *Olhof* for *Hevelius*, it will appear how much the World was then of another Mind.

A N 8th Thing is the Use of a Micrometer, &c.

Concerning which I shall refer to our Philos. Transact. N^o 352, where I have given a sufficient Answer to his Claim of the French Gentlemen, by asserting that and other Inventions to Mr. Gascoigne.

W. DERHAM.

It would be too tedious to mention all the Particulars, which he intitles the *Royal Academy* to the Honour of the Invention of, to which, in Truth, they have no just Pretence of Claim. However, I conceive, it might not be improper for some Person to vindicate the right and just Claim of this *Society*, that may stop the Mouths of some malicious Men, who will needs say, that this *Society* hath invented or improved nothing of real Use.

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